METHODS

OF

LOGGING FIR IN THE STATE OF WASHINGTON

By

FRAZIER CURTIS

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Index.

PREFACE.

Division of Forester,
Department of Agriculture,
March 10, 1900.

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of Seattle and Mr. John Allman of Hoquiam. From the men who were working in the woods, the author has received every help. He wishes particularly to record his obligations to the crew of Camp 5, Simpson Logging Company, at Matlock, without whose aid this report could scarcely have been written.

(Signed) FRAZIER CURTIS,

(Student Assistant Division of Forestry).

INTRODUCTION

The logging camps in the State of Washington vary in size from those employing half a dozen men and using as motive power a span of horses, to those which have a hundred men on the pay roll and which haul their logs with a 50-ton geared engine. Between these extremes are camps of all sizes and with many kinds of machinery. On account of these variations it is impossible to describe in detail the different stages through which any one log would go on its journey from the stump to this mill. In no two camps would its experience be absolutely the same. In a general way it would undergo the following processes;

After the tree has been felled, it is sawed into logs which are rounded at one end and barked on one side preparatory to being hauled from the woods to the skid-road, generally by a donkey-engine. The log is next hauled along the skid-road for a half mile or so, usually at the end of a steel cable wound by a road engine, until it arrives at the landing. There it is rolled on a logging car, chained down, hauled to the "boom," unchained and rolled into the water. Then it is made up as part of a raft some 800 feet long and 70 feet broad, which is towed to a mill somewhere up on the Sound. Such is a simple account of logging, without describing in detail such difference in methods for example, as that between hauling logs with a horse team and doing it with a road engine.

The first man to handlenthe log is the "undercutter." His duty is to pick out the trees suitable for being felled and to make a deep notch or "undercut" in them on the side of which they are to fall. After the undercutter come the "fallers," who work in pairs. They saw down the trees that have been undercut and mark the places where the "buckers," or conveyors are to saw them up into logs. After the buckers are through, the logs are ready for the "barkers." As their name signifies, the barkers' duty is to remove the bark from the straightest side of the log, in order to make it easier to haul through the woods and along the skid-road.

The "sniper," who is the next man to handle the log, rounds off, or "snipes," its front end so it will not catch on any obstructions, such as roots or stumps. Most of these will, however, have been removed by the "swampers," whose duty it is to work a little in advance of the donkey crew and clean out, or "swamp," paths from the skid-road to the log. They "buck up" the windfalls, chop down brush, which they throw to one side, and in general try to make the passage of the logs through the woods as straight and easy as possible.

The log is now ready for the "yarding" crew. Their work consists of running out a small steel cable, attaching the hook at its end to a sort of noose which has been slipped around one end of the log, and then giving the donkey engineer the signal to wind in the cable on his drum. This he does until he has

"yarded" the log,--sometimes through 800 feet of forest,--to the skid-road where the donkey engine is set. This is perhaps too simplified a statement of yarding. When it is remembered that it is not uncommon for sticks over 100 feet long and 3 feet across the top end to be yarded over hilly ground studded with stumps, the difficulties of yarding may be better understood.

After the log has been brought to the skid-road it is hooked in line with three or four others, making up what is called a "turn," each log being coupled to the ones ahead and behind by a pair of hooks driven into the ends. Thus coupled together, the turn is dragged along the skid-road at the end of the cable, which is wound in by the road engine situated on the landing. Or, instead of by a road engine, the turn may be hauled to the landing by ox team or horse team. Sometimes instead of being taken along a skid-road, it is hauled between the rails of a railroad track by a geared engine. On arriving at the landing the turn is uncoupled and the logs are ready to be loaded on the logging cars. They may simply be rolled on with "jacks" or handled by hooks at the end of a "loading-line" on a donkey. Sometimes the motive power at the end of the line is a locomotive, sometimes a span of horses. In one way or another the log is rolled on to the logging car, where it is held in place by chains, or if it is on a flat car, by stakes set in iron coops along the sides of the car.

The log is then hauled to its destination. In some cases it is taken direct to the mill; more often, to the "boom," where it is unloaded into the water, usually by means of jacks. At the boom its falls into the hands of the "rafters" who, with long "pipe poles," make up the rafts which are towed to the mill. If the boom is on a river, the logs may be made up into what are called "round booms," 6 or 8 70-foot "boom-stocks" chained together in a circle. These round booms are let drift down to the mill, in charge of a rafter, who ties them up to the bank with a long cable in case the tide turns before they reach the mill pond.

Before it is taken to the mill, the log has to be scaled, that is, an estimate must be made of the number of board feet that can be sawed out of it. Sometimes this is done at the landing, but more often the logs are scaled after they have been put up into a raft at the boom.

After the log has been scaled and rafted, the logger's responsibility ceases. In nearly every case the mill owner undertakes to tow the raft to his mill at his own expense. All that is left for the logger is the trouble and expense of having his boom-stocks and boom-chains, towed back to him.

In the brief sketch that has been made of the journey of the hypothetical log there is perhaps something misleading if it has given the impression that the work of a camp consists of a series of disconnected operations. In reality, a well run

camp is an organization with independent parts. Speaking broadly, the work of most camps revolves about the yarding donkeys. The skid-road men must have road enough laid out for the donkeys to move to when ready, while the crew in the woods must have enough logs bucked up and barked and sniped to keep them running to their fullest capacity. The road engine must be capable of hauling all that they yard and there must be enough loaders to keep the landing from becoming congested. Altogether, the work in a logging camp might in some ways, be compared to a procession.

FALLING

The timber fallers' work consists in choosing the trees to be felled, sawing them down, and marking by notches the places where they are to be cut up by the buckers. In some camps these duties come entirely on the fallers, usually two in number, but usually the work is divided between the fallers and the undercutter. As a rule, the undercutter works somewhat in advance of the donkey crew. At some camps the foreman makes it a point to have one, and sometimes two, or three, days' logs prepared for the yarding donkey; at others he prefers to have the donkey "chasing" the woods crew. As a rule, the undercutter works some three or four hundred feet ahead of the donkey crew, usually on the side of the skid-road opposite from that on which they are yarding, so as to keep them well out of the reach of falling trees.

The undercutter begins work by walking through the woods in order to judge of the "show" the country affords for yarding. His next consideration is with the actual trees to be felled. The undercutter has to determine whether or not a tree is worth taking and he may have to change his standard at every camp he goes to. At some he has instructions to take any tree which looks as if it might contain one log, while at others he is told to take no chances.

When he has found a tree that seems to have enough lumber in it to justify cutting, he makes a more thorough examination, for any signs of unsoundness. He tests doubtful

trees, more particularly those with swelled butts, by striking them with his axe at about shoulder height to see how the wood feels. Its slant, would, of course, have much to do with the direction in which he would fall it.

The choice of direction in which he falls the tree depends upon a number of things. First of all, he must fall it, if possible, so as to save the most timber. If there are windfalls or other obstructions near the tree, he must fall it to avoid them. He must avoid breaking any timber which has already been felled. If he is working near a gulch, he should fall it to lie along the side of the hollow, not across it, otherwise it would be apt to break. If he is falling one of a thick stand, he has to take great pains not to let it lodge in one of the other trees. Quite often, the tree is leaning so much that it is bound to take one general direction, in which case the best he can do is to undercut it so as to pull it a little to one side or the other. The undercutter usually determines the natural inclination of a tree by sighting past his axe handle, which he suspends like a plumbline. Where all the conditions are favorable he will fall a tree in the direction in which it leans.

The undercutter also has to keep the yarding crew in mind, and, other things being equal he falls his trees toward the skid-road, so that the logs can be more easily yarded. In hilly localities, where the trees are being yarded from the bottom, he usually falls them down hill to bring them nearer the

yarding crew. This falling trees in a straight line toward the donkey is particularly important when the trees are destined to be bucked up into long sticks, since a great deal of ground would have to be cleared if the sticks needed to be turned. The undercutter also tries to save the fallers unnecessary wedging by aiming a large proportion of leaning trees in the direction they would naturally take. In some instances he sacrifices clear timber in order to save wedging for the fallers.

When the undercutter has finally decided upon the direction, he "boards up," that is, makes holes for his spring boards. These two notches he makes below where the ends of his undercut are to be, and at the most convenient distance for chopping. The springboard on which the undercutter stands is usually 4 or 5 feet long by about 8 inches broad, an inch and a half thick at the outer end, and 3 inches through at the end inserted in the notch in the tree. The board is prevented from slipping out by an iron shoe on its upper side. When the board is placed the hole and its outer end forced down by the undercutter's weight, the shoe is driven into the wood at the top of the hole. Thus the board is kept on a level, but can readily be swung around with the shoe as a pivot.

The size of the undercut varies, but is usually from a third to a quarter of the diameter of the tree. The depth depends a great deal on circumstances. In a tree that is leaning forward heavily, the undercutter will make a deep undercut in order to give the tree less purchase, thus insuring a clean break

and preventing the outside wood at the back from splitting. On the other hand, if the tree leans back from the undercut, and needs wedging, he usually makes a small undercut to give the wedges greater power. The undercutting is always done with an axe except in camps where the fallers do their own undercutting; then they usually saw the bottom of the undercut instead of making it entirely by chopping. As a rule there is a separate undercutter and in his hands rests the practical determination of the height of the stumps.

As to this it is difficult to generalize. Various undercutters have informed the writer that the height of stumps has been much reduced in recent years. One undercutter had, in times past, boarded up to undercuts 20 feet above the ground. In these days competition among loggers was keener than at present. Another old-time logger stated that on one claim of 160 acres there had been 2,000,000 feet of available lumber left in the stumps. At present there is no such extravagant waste due to high stumps, but in general it may be said undercuts are made high enough to be above any pronounced swelling and also to keep clear of the underbrush. It is, of course, greatly to the timber fallers' advantage to make high stumps, or "long butts", as the wood is easier to chop and saw. They have no definite day's work laid out for them; at most camps all that is asked is that they should fall enough trees to keep ahead of the yarding donkey. The higher the stump, the less the work, and the tendency of the men who do the actual falling is naturally to cut higher than necessary.

At one camp seen by the writer the contract called for stumps of not more than 4 feet, with the proviso that the undercutter could go higher for any good and sufficient reason such as unsoundness. As a rule, the contract was disregarded by the timber-fallers, who cut the stumps chiefly to suit their convenience and seldom as low as 4 feet. These statements do not, however, apply to small second growth used chiefly for piling, which is sometimes cut within 2 feet of the ground. On the whole, there is not much extravagent waste. "Reasonably low stumps" was the expression used by one foreman in speaking of the height limit demanded by the owner of the timber, who was letting out the stumpage, and this might well apply to most of the camps in the State.

It is impossible to give any accurate figures as to the amount of work which is expected of an undercutter. At many camps where there is one undercutter to a yarding crew, he cuts from 45,000 to 50,000 feet a day. Two fallers, doing their own undercutting, can handle as much as 30,000 feet a day, but in most cases, the fallers are obliged to do only the actual falling.

The steps in falling are to clear away the underbrush, chop the board holes and cut away the bark in the line of the saw-kerf. This may be from 2 to 6 inches above the bottom of the undercut. As a rule it is about 2 inches, but if the tree is leaning much in the direction in which it is to fall, it is

necessary to make the cut some 6 inches higher in order to bring about a clean break and to prevent the tree from splitting up into the first log. When working on small, second-growth trees, the fallers may simply saw straight through, but with the fir of ordinary size the method is different. They avoid, as much as possible, sawing the whole width of the tree, and by occasionally changing the direction of the cut they are continually sawing across a corner. They oil the saw frequently, to prevent it from becoming gummed by pitch, using either kerosene or a mixture of this and some thicker fluid, usually dogfish oil.

Working from corner to corner, they saw until they come to their last corner, which is nearly parallel to the undercut. About five minutes before the tree is ready to go, they call out "Timber!" as a warning that the tree is about to go down. Or they may warn those working near them more specifically by calling "Watch out up the road," or "Watch out down the hill!" After pulling out the saw, they jump down from their spring boards, take them out, and run back close to some large tree where they can watch the fall in safety. It is quite likely that this will be followed by another, for the large trees are apt to knock down smaller ones in their fall. The most dangerous are those which are knocked over at right angles to the line of the first one. These are called "side-winders" and are responsible for no small number of fatalities in the woods.

The description of falling given above applies only to trees which are standing fairly straight, when working on trees that are in any way peculiar, the faller has to vary his methods. For the first instance, take one which leans heavily and is to be felled in the direction it leans. Such a tree would naturally break off while there is still considerable wood holding it to the stump. If any of this wood is on the outside of the tree, there is a good chance of its splitting up the side of the butt-log. To prevent this the fallers make side cuts. The result is that when the tree falls there is nothing to break except the wood on the inside of the stump. In trees which lean in this way it is also customary for the undercutter to chop a deep undercut, since this tends to make the break a sharp one.

A tree which is leaning back from the undercut, is much more tedious to fall, for it requires a great deal of wedging. As a rule, trees are felled in the direction they lean, but when there is a donkey, a railroad track, or some obstruction in the way that would break the timber, they may have to be wedged backwards. Such a tree would have a small undercut, so as to give the wedges all possible leverage, and the uppercut is made fully 6 inches above the undercut, in order to prevent splitting and to remove any chance of the tree's falling backward. As soon as the fallers find the way beginning to bind, they hammer in a short steel wedge, some 7 inches long and 1 inch thick, placing it in the middle of the saw cut. They continue sawing and driving wedges until they have sawed close enough to

the undercut. Then comes the hardest wedging of all, for before the fallers have finished, they may have to drive all five wedges, one on top of another, in order to force the tree backwards. At one camp the writer saw a fir about 5 feet in diameter and 250 feet high, wedged back from the railroad track, until it had been lifted about 5 inches from the stump. Wedging might also be employed where the faller is working on a tree which he wishes to draw slightly to one side. In such a case, the fallers would on their last cut leave most wood on the side toward which they wished to fall the tree. This has a tendency to pull the tree to one side, which is assisted by wedging.

Different treatment is necessary for a tree which is rotten about the heart. As a tree of this sort is apt to fall while there is still considerable wood holding it to the stump, it has to be sawed on all sides to prevent any outside splitting. After the first cuts have been made along the sides, it is sawed through from behind. A tree which is being felled in a high wind is sawed in much the same manner as one that is unsound; that is to say, all the outside wood is cut, so that if the breeze knocks the tree over to one side there will be no splitting. At such times falling is a dangerous business, as it is impossible to determine the direction with any great accuracy. Another very troublesome tree is a fir with wind shakes which keep dripping pitch on the saw. For this the faller can do little beyond washing the saw with water or kerosene.

The faller's work on the tree is not completed when it has been felled. It is the duty of the head faller to measure the logs for the buckers, marking the places where they are to be bucked up by notches on the side of the tree. The measuring he does with a 10-foot pole. In doing this he has to take a number of things into consideration. In come cases his work is simplified by the fact that the logger is trying to fill an order for a number of sticks of a certain length. In such a case, the list is given to the head faller, who checks off the logs as he marks them. When the faller has no list he must use his judgment. He tries to make the logs come so as to use up all the clear timber and also to be convenient to buck up. He must also make his logs come so as to scale well. For this reason he would have a long, curved tree sawed into short logs, and would be more apt to make a long stick out of a tree that did not taper much at the top than out of a conical one. At some river camps long sticks are avoided as being too apt to make jams, and at others, where the yarding is done by horse teams, they are seldom taken on account of the extra time and trouble involved. Even at camps where yarding is done with an engine, the hook tender is apt to object to yarding too long a stick on rough ground. In many camps there are apt to be some standard lengths, seldom shorter than 22 feet; perhaps 24, or 28, 32, 36, or 40.

As to taking top logs or not, the faller has to use some judgment; although he is guided largely by his instructions, which vary from camp tp camp. At one he is to take down to 16

inches, at another to 13; at some, he is to avoid second quality; while at others he is to take second quality down to 6 inches. Speaking broadly, it may be said that a logger who has bought his timber outright is more likely to log everything, including second quality, than one who is paying high stumpage.

If the faller's position is one of responsibility, it is also well paid. A head faller receives about $3 a day, and a second faller seldom less than $2.75. The undercutter's pay ranges from $3 to $3.25. These wages are about as high as any in this camp. As a rule, there are two fallers and one undercutter to each donkey. Occasionally there are four fallers and one undercutter, an increase necessary where the logger takes all trees which contain one log, and when such trees are numerous.

The outfit of the undercutter consists of a double-bitted falling axe, a springboard, and usually a pocket whetstone. The axe, which weighs about 3-3/4 pounds, has a very narrow head and a handle some 42 inches long. The price complete ranges from $12 to $14 a dozen. The outfit of the two fallers consists of the falling saw, two falling axes, two springboards, an oil bottle, a set of five wedges, a sledge hammer, and a 10-foot measuring pole. The saw is usually between 8 and 10 feet long, about 4 inches wide at the ends, increasing to 6 inches at the middle, and about 1/16 of an inch thick across the back, the teeth being somewhat thicker. The teeth are of two

sorts, which are alternated, the "rakers" and the "cutting" or "saw" teeth. As their name indicates, the latter, which are about 1/32 of an inch longer than the rakers, do the cutting. The rakers plane off and carry away what has been cut. This arrangement will, however, be more chiefly explained under the head of "filing." The handles, which are something over a foot in length, are clamped on the ends and are readily removable. The care of the saw generally devolves on the head-faller, who as a rule, files it every other day. A fair estimate for the life of the saw would be from four to six months. They are bought by the foot and at about $1.20 a foot, with discount, the total cost amounts to a little more than $8, exclusive of the handles. The faller's axes and the springboards are like those of the undercutter. The oil bottle has a curved hook fastened to the neck, by which it can be hung on the bark. The wedges, which are usually five in number, are "packed," i.e., carried, in two bags, sometimes made of old rubber boots with an strap between to go over the shoulder. There are usually three short and two long wedges, made of one-inch steel, and about 3 inches broad at the blunt end. The long ones are about 13 inches, the shorter about 7 inches in length. Besides these, the fallers carry a sledge hammer weighing from 10 to 12 pounds. This with the filing set and the pole, completes their outfit.

BUCKING

"Bucking" consists in sawing up the trees at the places which have been notched by the faller. The buckers, who follow close on the heels of the fallers, have to keep enough logs bucked up to supply the yarding crew. To do this usually requires three men.

To saw off a log seems a comparatively simple matter. Nevertheless, the bucker has to adopt different plans according to the differences in the positions of the trees. Usually, however, he has only to consider four cases: trees lying flat on the ground, those hung from the ends, those with one end hanging over unsupported, and those which are caught between trees or stumps in such a way that they are bent to one side, and ready to spring when sawed through. A tree in the position last named is said to be "side-bound." When the tree is lying in the first position, that is, touching the ground all along, the bucker's work is not complicated. After chopping away the bark from the line of his cut, as this is apt to injure the teeth of his saw, he can easily saw through to the bottom. He works rather differently on a tree hanging in the middle, usually sawing two-thirds of the way through from above and finishing by "undercutting", that is, sawing up from the bottom. When undercutting, he rests the back of his saw on the branch of a sapling which he leans up against the tree, holding it there with his axe.

Another common way of bucking up a log in this hanging position is to saw it through from above, keeping the cut open by wedging. The chief objection to this method is that when the ends fall one is apt to drop farther than the other, in which case it may have a "slab" splintered from the top, running back some 3 or 4 feet and as deep as the wedge goes in. If the tree is not badly hung, and is not too large, the buckers may do all the sawing from above and yet prevent the waste of any timber by the use of "hanging wedges." These are merely ordinary wedges driven in with the grain across the cut so as to hold up both sides and to make them drop evenly.

The third position is that of the tree which lies with one end unsupported. In such a case, the usual way is to undercut until the saw begins to bind and then to cut down from the top until the log falls. When working on a side bound tree the bucker starts by chopping a deep cut on the inner or concave side, after which he saws on a slant, taking as much as possible of the outer side.

The usual number of buckers to one donkey (yarding about 45,000 feet daily) is three. At some camps there are only two; at others there are four. When many long sticks are being taken out, the buckers' work is comparatively easy, since there are fewer logs to be made. Their wages range from $2.50 to $2.75, and, very rarely, run as high as $3.

A bucker's outfit consists of a saw, an axe, a sledgehammer, a bag of wedges and an oil bottle. The saw is usually

from 7 to 9 feet long and about 4-1/2 inches across the ends, widening to 7-1/2 inches across the middle. It is rather thicker and less flexible than a falling saw, being about 1/16 of an inch thick at the back and almost 1/8 at the teeth. It is filed every other day or so and with good care may last 6 months, after which it is usually passed on to the swampers or graders. It costs about $6. The bucker's axe has a handle seldom more than 40 inches long. His wedges, five in number, are about 7 inches long. At some camps another addition to the bucker's outfit is a patent undercutter. This consists of a small, round bar of iron about 2 feet long, with the upper end sharpened and bent at a right angle, so as to be driven into the side of the tree. The bar is notched at short intervals, the notches being for the purpose of holding a small wheel which may be slid up and down and which supports the back of the saw. This device has proved fairly successful, but is not in general use because of the inconvenience of carrying it. Besides these tools, the bucker, like the faller, has his filing set.

FILING

An important part of any kind of wood sawing is the filing of the saw. A saw which is being filed is placed, teeth upwards, in a "filing-bench" or "saw-clamp", consisting of two horizontal boards supported by posts about 4 feet high. The filer begins by "setting" the saw, that is, by straightening the cutting teeth. As the cutting is done by the outside edges, there is an inward pressure which tends to throw the teeth out of line; if left this way, they cut too narrow a kerf and the saw "binds."

In order to determine whether or not they are in line, the filer uses a four footed gauge. He rests three of the feet on the side of the saw and touches the fourth one on the point of the saw tooth. If this proves to be leaning out of line, he straightens it either with a small hammer or a pair of pincers.

He next looks after the rakers, which he files only across the top, using a small and rather fine file. When he has filed them to suit, he knocks down the points with a small hammer, so as to give a better biting edge like that of a plane. This is called "swedging," (Swaging) the hammer being known as a swaging hammer. Filers vary as to the angle to which the rakers are swaged. Some make it a rule to swage to such an angle that the line of the raker if continued into space would come just a quarter of an inch above the point of the next cutting tooth.

After filing the rakers, the filer turns to the cutting teeth, which are filed on the inside edges up to a triangular point. The sharper the angle the easier the saw cuts, and the faster it wears out. Besides filing the sides, the filer runs a gauge over the tops of the cutting teeth. If they are not the same height, he may put a file in the bottom of the gauge and reduce them to a level. This leveling of the saw teeth is called "jointing." By the aid of the "raker-gauge" he can also determine whether or not the rakers are the right amount shorter than the "saw-teeth." With filers, this distance is about one-thirty-second of an inch. Some gauge it by the thickness of a silver dime. It is important to have the rakers even, otherwise the saw has a tendency to jump.

Such, in a rough way, is the method of filing. In theory it is simple enough, but in practice it takes not only some skill, but a good deal of experience. It is important to have the saw teeth all level, for if those on one side are longer than those on the other, the saw has a tendency to run in a curve. Every sawyer files to please himself; a saw which would be too easy running to suit one man might be too hard running for another. As a rule most of the sawyers, from the fallers down to the graders, do their own filing. At a few camps a regular filer is employed, who is usually an experienced woodsman, and receives good pay, ranging from $3 to $3.50 a day.

An argument in favor of employing a filer, is that then a foreman need never be at a loss for fallers or buckers, for there are men about camp who can, on a pinch, do the actual falling or bucking, but who are unable to file their saws. Another argument is that the sawyers can be working all day, and do not have to lose time. On the other hand, a good sawyer usually objects to letting anyone but himself file his saw, and at a camp where a filer is employed, a bucker who does not seem to be doing a day's work may justify himself by saying he is doing all he can with a saw which is not filed to suit him.

The faller or bucker who can do his own filing is, of course, a better workman than the one who can not and in this connection it seems significant that at the first camp where a filer was employed visited by the writer, the wages of the head faller were the same as those of the second faller, $2.75 a day. A possible inference is that the employment of a filer goes hand in hand with lower wages and less skilled workmen.

BARKING

Barking consists of removing the bark from the side of the log on which it is to be hauled. In the Red Fir woods, the log is rarely peeled. The "barker" has to use some judgment in picking out the flattest side so that the log will stay on the "ride," as it is called. In case it rests on its flat side, the barker asks the hook-tender to turn it over. He usually does the actual barking with a broad axe having a bent handle from 38 to 40 inches long, but in summer, when the bark is soft and easily removed, he may pry off the bark with a "spud" or "barking-iron," an instrument resembling a short, chisel-pointed crowbar.

If the barker uses an axe, he tries not to shave too deeply into the soft underbark between the wood and the outer-bark. This sappy layer serves as grease in skidding, and even when it is finally rubbed off, the log is left much smoother than if it had been originally barked down to the wood. A small cut or two makes little difference nowadays to a powerful yarding donkey, but in the days of bull teams any roughness on the logs made an appreciable difference in yarding. Sometimes it is necessary for the barker to cut away a good deal of wood, as when a burl or other projection comes on the side, or when a log has one end flat and the other curved so the curved end has to be flattened in order to make the log "track," or stay on the ride. A hollow-backed log may have to be flattened at both ends. At some camps, and in some seasons, barking is dispensed

with entirely. Foremen who have had experience in yarding logs in rainy weather over clayey ground say that under such circumstances a barker is unnecessary.

There are usually two barkers to each donkey, although one is sometimes found sufficient. At one camp seen by the writer, where the donkey was yarding not much over 30,000 feet, the barker also did the sniping. A barker's wages average $2.50, seldom running much higher or going below $2.30.

SWAMPING

The swamper's duty is to clear out, or "swamp", the roads over which the logs are hauled through the woods to the skidroad. These roads are merely cleared paths from the log to the donkey. There are usually two swampers to a donkey, one of whom does little but buck up windfalls, while the other chops down underbrush and piles it one side. Their chief lookout is to make the roads as short and as straight as possible. This reduces the number of blocks necessary and lightens the work of the donkey crew. In fact, a good swamper can be of great assistance to the hook-tender, since his swamping practically determines the course of many of the logs. As a rule, there is one main road, running out from the donkey, which gets pretty well worn before the engine is moved from its "setting." The others branch from this main road straight to the logs.

The breadth of the roads depends upon the nature of the ground, the size of the timber and so on, but as a rule they are seldom wider than 7 feet. When the swamper is piling up the brush at one side, it is important for him to put it in some place where it will not have to be removed for another road. The main consideration, however, is to swamp the roads in such a way that the logs can be yarded easily. The swampers remove all they can, but of course they have to leave the larger obstructions, such as windfalls and broken logs, to be removed by the donkey crew, an operation known as "chunking." A great deal

has to be left to the swampers' judgment in choosing the best places for the roads. In hilly regions they are apt to swamp out the gulches and to make the roads straight up and down the hills, for a road run diagonally up a steep hill gives the log too many opportunities to roll over.

Swamping for a horse team is rather different from the ordinary method. In the first place, a horse team seldom yards farther than 200 feet, usually a great deal less, and does not need such long roads as a yarding donkey. On the other hand, since the road should be broad enough for three span to work in comfortably, it is sometimes made as wide as 10 or 11 feet. It should also be as straight as possible, for a team can not pull effectively around a curve.

At some camps there is a head swamper and a second swamper. The former determines where the roads are to go and does the bucking up of the windfalls, while his assistant chops away the underbrush. In such cases the head swamper receives about $2.50, sometimes a little more, while the second swamper has to content himself with about $2.25. If there is no difference in rank, their wages are apt to be between $2.25 and $2.50. The nature of their work depends upon the region they are working in; if it is smooth, with few windfalls and little underbrush, they may not have much to do. During the winter, however, it is apt to be disagreeable work, since they are constantly in the wet underbrush.

Their outfit consists of an old bucker's saw, a sledge, some wedges, and a swamping axe apiece. These axes weigh about 4 pounds, and have handles between 38 and 40 inches long. They are rather broader than a falling axe, but not so broad as a sniping axe, the width across the edge being some 5-1/2 inches. Quite frequently the swampers find it best to add to their outfit a pair of gloves, more particularly when working in moist country where there is much Devils Club, a plant covered with large stiff thorns.

SNIPING

The "sniping" of the log, called "nosing" in the East, is the last process it undergoes before being hauled through the woods. It consists of rounding off the under side of the front end of the log, so that it will not catch on any obstructions, but will slide up over them. In "rough country", where the log is apt to roll and to be yarded first on one side and then on the other, it is usually sniped all the way around. The sniper uses a heavy axe weighing from 5 to 6 pounds and somewhat broader than the ordinary swamping axe. The depth of the sniping depends partly on the size of the log and partly on the conditions. Where the logs are being yarded for a short distance and over smooth ground the sniper does little more than take off the edge. In small camps the sniping is often done by one of the yarding crew, who snipe each log as they come to it. As a rule there is one sniper to a yarding donkey and in fact he is often counted as one of the donkey crew. Snipers' wages do not vary much, seldom running below $2.40 or above $2.60.

YARDING

Yarding consists of hauling the log out from its first position in woods to the skid road. The distance which it is yarded seldom exceeds 600 feet, although on occasions yarding donkeys have been known to work at 900 feet. The motive

power is usually a donkey engine which winds in on a drum a steel cable attached to the log. At a few camps horse teams are used instead, and at an extremely limited number, yarding is still done by oxen. In a general way it may be said that the last few years have witnessed the gradual evolution of the yarding donkey and that improvements are still being made on it. The latest donkeys are remarkable for their power. The writer has seen one yard a 100-foot stick, some 3 feet in diameter at the smaller end, up a slope rather steeper than 45 degrees. The ease with which enormous logs are handled by these engines is astonishing.

Before giving an account of actual yarding, it might be best to explain the general theory of camp work. A common arrangement is to have the landing from which the logs are loaded on to the cars supplied by two main skid roads, one joining it at each end. These run out and ramify, covering the country for a distance of some three to four thousand feet with a network of branch skid roads. The district which is thus skidded is in the shape of a half-circle, of which the landing is the center. At one end of the landing is set the road engine which hauls in the logs from the yarding donkey.

Then the yarding donkey, preceded by the timber fallers, buckers, barkers, and so on--the wood crews, as they are called--works out from the landing, going out first on one branch road and then on another, hauling itself about by its

own cable attached to trees along the road. On arriving at a "setting" it works until it has yarded off a quarter circle on one side of the road--sometimes on both sides--with a radius of some 600 feet. Then it moves out about 600 hundred feet farther and répeats the process until it has to come back in order to start on the next road. The wood crew, meanwhile, make it their business to keep enough logs ahead for one, and usually for two, day's yarding. In this way the donkey keeps on until it has yarded the quarter circle at one end of the landing. Then the road engine moves to the other end of the landing, facing the unused skid road, and the same process is repeated and the second quarter circle is logged off. Then the whole outfit has to move to a new landing. At large camps there may be several yarding donkeys and a corresponding increase of activity in all the other parts of the system.

This is, of course, merely one of a large number of methods of logging. Even where the landing and skid roads are laid out as described, the yarding may be done working in from the ends of the roads and not out from the landing. Both ways have their advantages and disadvantages.

Then, in many cases, owing to the hilly nature of the region it is impossible to follow any preconceived scheme of skid roads or to do anything but make them wherever there is a good place and yard outward or inward as may seem best. When locomotives are substituted for road engines, the yarding is

done in much the same way. The donkeys move themselves to settings along the track, yarding the logs into turns, which are left between the rails until the locomotive hauls them over the ties to the landing.

The donkey crew which does the yarding consists of from 6 to 9 men. Of these, two, the engineer and fireman, are occupied solely with the engine, so their duties need not be considered here. For some donkeys there is also a drum tender and a "flunkey" to chop fuel and "pack" water.

The members of the crew who do the actual work in the woods are as follows: The hook tender, usually a second hook tender, a rigging slinger or two, the sniper (for as he works very little in advance of the crew, he is usually counted as one of them), the line horseman, and the signalman. The hook tender, who is in charge of the yarding, directs the setting of the blocks and in general plans just how and where each log is to come out. The second hook tender and the rigging slingers carry out his orders, set the blocks as directed, and do the actual work of fastening the hooks into the log. Quite often the log is yarded by a sort of steel cable noose, called a "choker", which has to be wrapped round it, and in some camps the rigging slinger who does this is called the "choker man". The line-horseman's duty is to drive the line horse that hauls the cable out to the woods after it has come in with the log. The signalman's business is to stand where he can see both the

log and the engineer and give him signals to go ahead or stop as the case may be. The "hand-skidder" is another member of the crew who is found in a few camps. He is supposed to lay small hand skids, some 6 to 8 inches in diameter, along the swamping road in front of the logs which seem likely to come out with difficulty. This is seldom necessary and as a rule the hand skidder is dispensed with. In some camps the "coupling-up" man is counted among the donkey crew, but as his work consists of coupling logs together on the skid road after they have been yarded, it seems more exact to say he tends hook for the road engine. Of these positions many are interchangeable; the line-horseman sometimes doing the signaling, and so on.

The crew having been thus enumerated, the actual yarding may be described. The hook tender, on arriving in the morning, takes in the situation, determines in a general way where the logs had better come in, and has "leads" set at the first few corners; a lead consisting of a steel "snatch-block" fastened to a tree or stump. There are two ways of setting leads--the first is to use a "lead-line" made of a piece of steel cable from three-fourths to an inch in diameter, and some 15 feet long with eye splices at both ends. It may be noosed around a tree so the block can be hooked into one end, or it may simply be wrapped around and the block hooked into both ends. The other way of setting a lead is to use a "swamp-hook," a long, sharp, curved hook with two or three links at the end of the

shank in which to hook the block. This is stuck into the sides of trees and stumps, and if somewhat handier is less reliable than a lead line, since it is apt to pull out. In one way or the other the hook tender will have leads set at the turns nearest to the donkey, which is usually set quartering on the side of the road opposite to that from which the logs are to be yarded.

When all is ready, the line horseman fastens to the cable or line the chain attached to the singletree and starts the horse out to the woods. At the first lead he takes some slack, opens the snatch block--or simply "block," as it is usually called--puts in the line and closes the block again. This he repeats at the other leads until the horse has hauled the line out to the log. In case a road is swamped straight from the log to the donkey no leads would be necessary, but this is rather unusual. If the road has been thoroughly swamped to the log the hook tender can start in yarding; as a rule he has to do some "chunking," which is the technical term for the removal of windfalls, top logs, and any other debris too large for the swampers to clear away single-handed. In chunking, the hook tender sets a lead to one side and has one of the rigging-slingers put a "choker" around the "chunk." A "choker" is a piece of cable, usually one inch in diameter and 15 or 20 feet long, with a hook at one end and an eye at the other. When it is put around a log it makes a noose by passing through its own

hook and the end of the donkey cable is hooked into the eye at the other end. When the choker has been set, the signal man waves to the engineer to wind in the line on the drum until he has hauled the first chunk far enough to one side.

After the donkey crew have finished chunking, they commence with the nearest logs. The hooktender's first business is usually to turn the log over onto the barked side, or "ride" on the log. He is then ready to attach the line to the end of the log, which he may do in one of three ways; by the use of a choker, "dogs" or "grabs." A dog is a large steel hook which is driven in parallel to the grain, and which is generally attached by a short cable to a ring. The dog hook is useful for yarding small logs, but for larger ones it has not the tenacity of grabs.

A pair of grabs consists of two long and very curved hooks, fastened by a couple of links to a large steel ring. They are put in across the grain, the two hooks fitting into notches or grab-holes which are cut on the side of the log, one below the other. They are hammered in with a maul and when the pull comes on the ring between them it forces the grabs deeper into the log.

Whichever device the hooktender uses he puts quarter way around from the barked side, so as to keep the log on the ride. Then he puts in the "butt-hook," or "line-hook"--which is the hook at end of the cable or "line"--and signals to go ahead. When the log reaches the first lead, the signalman

has it stopped until the line has been taken out of the block. Then it is hauled to the next lead, and so on, until it is yarded up to the donkey on the road. The line is then run out by the line horse and another log is brought in, the second one bunting into the first and pushing it along the skid road. When there are three or four of these logs, one behind the other, they are chained or "coupled" together into a "turn" and hauled to the landing. At some camps the hooktender goes in with the log, often standing on it, while at others he sends in the second hooktender staying himself to plan the setting of the rigging for the next log.

This description would not apply strictly to all yarding. For instance, yarding long sticks over rough ground would give the hooktender much more trouble than has been indicated. In the first place he would have to use a great deal of judgment in picking out the shortest and quickest route and the one that would require the fewest hands. Sometimes he has to yard logs backward in order to get them out around stumps. Quite frequently the log sticks and will not budge until he has increased the power of the donkey by the use of additional blocks. In such a case the hooktender usually runs the line through a block set on the log and fastens the line hook to a tree. This fastening of the line hook is called getting a "tail-hold." It makes no difference where the line hook is set; that is, it is as proper to talk about getting a tail hold on the log as about having one on a tree. After the log has been

yarded up to the first tree, a fresh tail hold is taken on a tree nearer the donkey. When one block is not sufficient the hooktender will set more, sometimes as many as five.

As a rule the hooktender yards out the logs one at a time, taking them in the order best suited for the "turn". In making up a turn it is essential to have for the head log, one that is large and flat, those behind being coupled in the order of size with the smallest at the end. Sometimes two are taken abreast and at some camps, where they are yarding small timber for a short distance, two logs are coupled tandem. But when logs of average size are being ~~graded~~ yarded, one at a time is all that is practicable.

The way in which the line is taken back to the woods differs slightly from camp to camp. Usually one line horse drags it back and when slack is needed on account of extra tackle the horse has to go back a few feet and haul up the required amount. At one camp, where the yarding and hauling were both done by the same engine which was set on the landing, two line horses were required to take back the cable when more than 1,300 feet were being used. When the donkey is working on very rough ground the use of a line horse may be impracticable and a "haul back" line becomes necessary. This, as its name implies, is a small line which is run through a block out in the woods and hauls out the yarding cable. Since it undergoes little strain, it is seldom larger than five-eighths of an inch, and is about double the length of the main cable.

When a haul-back is used, the first thing to be done is to set up a "tail-block" for it to pass through near the logs which are to be yarded. When it is wound in it carries back the cable faster than it can be taken in by a line-horse. The chief objection to a haul-back line is that it necessitates the frequent moving of the tail block. Wherever it is possible to use line-horses they are generally employed. At one camp seen by the writer, where the precipitous nature of the country forbade the use of line-horses, they had devised a method of using a haul-back line which did away with the necessity of frequently changing the position of the tail-block. The striking feature of this particular arrangement consisted in the use of what was known as "long rigging." The tail-block was set up about six hundred feet from the donkey and in the midst of a number of logs lying on both sides of the main swamped road. When the hooktender came to a log, say 50 feet to one side of the road, he would have a special piece of cable about 50 feet long hooked to the choker and run through a lead on the farther side of the road. Then, when he had yarded the log up to the lead, the hooktender would take off the "long-rigging" and have the line slacked back until the line-hook could be fastened to the choker. After that the log would be yarded in the ordinary way. The "long rigging" used was of different lengths between 25 and 75 feet, and the yarding crew, exclusive of those working on the donkey, consisted of one head and one second hooktender, two rigging-slingers, and a signal-man.

YARDING WITH HORSE-TEAM

Although the yarding is done in most camps by means of a donkey engine, there are quite a number where horses are used. At a very few the yarding is done with oxen. The number of such camps in Washington has been estimated to be about a dozen. Horses are, however, still used by a good many small loggers.

There is great similarity between yarding with an engine and with a horse-team, the difference lying chiefly in the increase of power gained by the use of a donkey. Another difference is that the condition of the team has to be considered, whereas an engine can be forced to its utmost capacity. An engine can also work on rough ground where the use of horses would not be practicable. The practical result is that a man who is logging with horses will not work a claim that does not offer good facilities. He tries to find "good country" where he can be sure of getting out his timber down-hill. And by skidding fairly close, having his skid-roads not more than 500 feet apart, he can make sure of short yarding.

When horses are used, the actual yarding is usually done by three span only, since that is about all that can be conveniently handled in the woods. If there are five span altogether, the teamster "cuts out" two, usually leaving the leaders and two others. The place where they are to work has already been swamped out to a width of some ten feet, so the teamster can drive his team in and turn them, the skid greaser meanwhile carrying the spreader behind the last pair. He fastens

the spreader hook to the dog, or whatever device may be used, and all is ready for the team to go ahead. If the team cannot haul the log the teamster sets a block, and if they are still unable to move it, he sets long rigging to a lead in the skid-road where he can get a straight pull with all five span, something that is seldom possible in the woods close to the log. Even when only three span are used, it is sometimes difficult to find a place for a straight pull and an extra lead or two may be necessary. The leaders have to be taught to ease up on curves so as not to force the span behind them into the underbrush.

As a rule, the teamster uses short traces for yarding, that is, the single-trees are close to the horses' flanks and do not drag on the ground. Where it is possible, he has his teamwork close to the log. The cable which he uses occasionally is a light one, usually five-eighths inch. There are pieces of different lengths, and each has a ring at one end and a hook at the other. The blocks are also lighter and made with smaller sheaves than are the ordinary yarding blocks. One arrangement of tackle peculiar to horse-teams is that known as a "luff purchase" to which may be added another block, converting it into a "luff and a whip." The noticeable feature of these combinations is that they entail more strain on the rigging than the ones used in donkey yarding. For this reason they are impracticable where engines are used, for the greater power would be apt to break the cable.

The loss of power is one of the greatest limitations of yarding with horses. They cannot yard uphill to any great extent, and they may have much trouble in handling long sticks. In muddy regions, or during rainy weather, they find it hard to get around. One great advantage over a donkey engine, however, lies in the saving of cable, as the wear on the short pieces of rigging that horse-teams require, is as nothing compared to the loss of some six hundred feet of three quarter inch cable in the space of one or two months. On the other hand, on rainy days the horses are costing the logger board, where nothing is lost on an engine. Of course the daily capacity of a donkey engine is much greater, but so also is the number of men employed. A horse-team requires only four men, teamster, skid-greaser, a hooktender, and a rigging slinger - the men doing their own sniping - while a donkey crew may consist of as many as nine.

The number of feet that a horse-team can yard in a day depends upon the chance. It is seldom, however, that one finds a horse-team doing nothing but yarding. A much commoner arrangement is to have the team yard out a turn and then haul it to the landing. The horse-team can, under favorable conditions, yard and haul 24,000 feet with a haul of half a mile. Between 30,000 and 40,000 seems a fair estimate for a team which is doing nothing but yard.

Yarding having been described as a whole, it might be well to give some idea of the part which is played by each

member of the crew. The importance of the hooktender's work has already been mentioned; it seems hardly too much to say that the camp work revolves about him. A good hooktender can command top wages, at some camps earning $5 a day. That a good one may be worth it is obvious when one considers that the number of logs that are yarded each day depends largely upon his judgment. At a camp seen by the writer, where two yarding donkeys were being used, one crew was taking out from 2,000 to 5,000 feet more than the other. The donkeys were of equal efficiency and worked under equally favorable conditions, the difference in the results being due to the fact that one hooktender was better than the other. With merchantable logs worth from $5 to $6 a thousand, this would mean that one crew with the same number of men was earning from $10 to $25 more a day than the other. As to the average wages of the hooktender, it is impossible to give any estimate, but they are seldom lower than $2.75 or higher than $5. The wages seem to depend somewhat upon the nature of the ground. If, for instance, they are yarding small timber on level ground, and never farther than 200 feet, no great judgment is required and the wages are correspondingly low. On the other hand, where big timber is being yarded in rough woods, the efficiency of the donkey crew depends largely on the hooktender, whose wages are in proportion to his importance.

Next to importance to the hooktender is the second hooktender. At camps where the head hooktender goes in with

the log, the second hooktender has to look after the setting of the tackle for the next one. The hooktender may have pointed out where the log is to go in, but the second hooktender has to use his own judgment as to just where to set his lead. He also does a great deal of the actual work, notching grab-holes, hammering in the grabs or dogs with a maul, helping the rigging-slingers to set the leads, "packing" around the blocks and running out the line when necessary. The second hooktender is in the line of promotion to head hooktender. His wages run from $2.50 to $3, but are usually nearer the former than the latter figure.

The members of the donkey crew who have the hardest manual work are the rigging slingers, whose duties are to set the rigging. They have to set the lead lines and put in swamp-hooks, to say nothing of carrying around the blocks, which have sheaves seven or eight inches in diameter and weigh about seventy-five pounds. Where a tail-block is used, it may have a ten-inch sheave and weigh over 100 pounds. Carrying the blocks in rough, muddy country and over windfalls is no easy task. The pay seems hardly proportionate, although it varies a good deal from one camp to another, $2.20 and $2.75 being the lowest and highest wages that the writer has actually found, although he has heard of rigging-slingers receiving as much as $3.

Another member of the crew who is often dispensed with, is the hand-skidder, who when employed, usually does the

signalling. In most cases there is a regular signal-man, who stands where he can see both the log and the engineer, and signals, usually by hand, for the engineer to stop, to go ahead, or to hold the line taut, or to do anything else that may be necessary. The signalling is sometimes done by the line-horse man, whose principal business is to drive the line-horse, which he does usually by voice. Good line-horses are extremely sagacious and do their work with little guidance, stopping at the leads for the line to be run through without waiting for the word of command. The last one of the crew is the sniper, unless the sniping is done by the hooktenders. The sniper's wages have already been given. The signal-man gets from $2.30 to $2.50 and the line-horse man about the same.

Any work in the woods has its perils, but the yarding crew seem to have rather more than their share. If the line breaks or the dogs pull out, it is well to be out of the way. The most dangerous position is inside the "bight," or curve of the cable. When a swamp-hook pulls out or a block breaks, the line springs in like a bow-string, usually with fatal results to anyone who happens to be in the bight. Rotten stumps or small trees are often knocked down by the line, and once a man was killed by this means within a few rods of the writer. Of course with good rigging the chances of accident are much diminished.

YARDING OUTFIT

The outfit of the ordinary yarding crew does not vary much from camp to camp, the chief difference being in the hooks which are put into the log. In a rough way it may be said that dogs are used most in small timber, chokers in medium, and grabs in large logs. Dog-hooks, which are made with a curve rather sharper than a right angle, are of various sizes, being from 10 to 14 inches in length, and usually of one by two inch steel, although they are occasionally made of octagonal steel. Some are round and some chisel pointed. Usually there are two dogs, one at each end of a chain or a piece of cable four or five feet long. Sometimes there is a ring in the middle of the chain or cable, for greater convenience in "crotching," that is, driving a dog on each side of the log so that the ring comes in the middle of the end. Usually, however, the dogs are driven in on the quarter, and parallel with the grain.

Grabs, which are of all sizes, are usually made of octagonal steel. They are usually connected with the ring between them by links, although at some camps cable is preferred as being tougher. Although grabs take more time to put in than dogs, they hold better and are easier to knock out. This is done by a few blows from a maul, whereas dogs have to be struck on the ring end and then pried out.

In chokers there is little variety. They are usually made of seven-eights or 1-inch cable, commonly plough steel,

with an eye at one end and a hook at the other. Their length varies according to the size of the timber the crew is working in, but they are seldom much over 15 feet. In some ways they are more convenient than dogs or grabs, as they require no notching or hammering. On the other hand, it may be very difficult to set them, as in the case of a log resting flat on the ground or lying close to another. The chief objection, however, is the cost. At one camp seen by the writer, where big timber was being yarded out of rough country, the foreman, who was trying chokers as an experiment, had used up 100 feet of choker rope in a week. At something like 28 cents a foot, this was rather expensive business. In smaller timber the wear is not so great. As a rule it comes at the place where the choker goes through the hook, the result being a bad kink. Hooks made of bar steel, one inch by three, instead of the usual octagonal steel, something over an inch in diameter, by reducing the sharpness of the turn lessen this defect someaht and the life of the choker.

Which of the three - chokers, dogs, or grabs, are preferable, it is impossible to state, as each has its advantages in certain conditions. Crews that are using chokers usually have grabs with them also for cases where the use of a choker is impracticable. As has been stated before, grabs are generally used in large timber, chokers in medium, and dogs in the smaller logs.

In the blocks there is also much variety, both in design and size. For a small yarding cable, such as that used for

horse-teams - usually five-eighths - a 6-inch sheave is thought large enough; while for bigger cables the sheaves run as large as 8 inches. At most camps the yarding is done with a three-fourths inch cable, although for big timber seven-eighths is not uncommon, and even one-inch cable has occasionally been tried. For these sizes a 7 or 8 inch sheave is usually thought best.

These blocks, or "snatch-blocks" as they are called in the catalogs, - although this name is seldom used in the woods - are solidly made of steel, some of the larger ones weighing as much as 100 pounds. The ordinary yarding block, with a seven or eight-inch sheave, weighs about 75 pounds. The sides are of quarter-inch steel plates bolted together at the bottom, and with half-inch "straps" or "lugs" bolted longitudinally across the middle of the plate. Into the top of these straps is hinged the bar to which the swivel is attached. This bar is lifted up to admit the cable, after which it is dropped in the middle of the outer strap and secured by a lock-pin which passes through holes in the strap and the bar. The pin can easily be knocked out by a sharp blow; and since it is often necessary to take out the cable when there is still some strain on the block, this style block is for this reason usually preferred to others. Usually there is a link and a hook connected with the swivel, although sometimes the link is omitted. Sometimes the block has only the swivel, but it then lacks

flexibility and is more liable to be broken by a sharp lateral pull. The snatch-block fastening with a pin is by no means the only sort used, but for yarding it is rather the commonest.

The sheaves - which turn on a sheave-pin with nuts outside the straps - afford even greater variety than the rest of the block. Where a three-fourths-inch cable is used a 7-inch sheave is not uncommon, while for a seven-eighths cable an 8-inch sheave some two inches thick is preferred. These diameters are measured from the bottom of the grooves. Some camps use sheaves of chilled cast steel, others use white metal, while at one camp the writer saw sheaves made of solid brass cast at a small foundry connected with the repair shop. All three kinds have their good points, but the white metal sheaves last longer than the chilled ones. Both are usually bushed with brass.

Although 8 inches is the largest sheave diameter for the ordinary blocks, a 10-inch sheave is usually employed for the "tail-block," where the line always has a sharp turn. A block of this size is also sometimes used for the first lead if there happens to be a sharp turn. An important factor in reducing the wear on the cable is the shape of the "shell," as the side plates are called. To prevent the cable from chafing against the sides, the upper part of plates is sometimes cut down almost to the edge of the sheaves, so that the block as a whole presents a pear-shaped appearance. Most of the blocks are bought originally from the manufacturers, the larger ones costing $15 and the smaller $10, while the sheaves cost

from $1.40 to $2.50, according to the size and material. The repairing is usually done by the camp blacksmith, who sometimes makes them outright, with the exception of the sheaves.

Another part of the yarding outfit which is made by the blacksmith is the swamp-hooks. There are generally two or three of these to a crew, besides three or four lead-lines. The "swamp-hooks" are rather longer than grabs, being intended to drive into trees and stumps. Usually they are round-pointed although some loggers prefer a chisel-point. As swamp-hooks are apt to pull out of rotten wood, they are less reliable than lead-lines, but, on the other hand, they can be more easily set, especially high up on trees.

Besides all this rigging the crew carry an ax or two for cutting "grab-holes," and a maul. Where dogs are used, the maul-handle is usually of steel and chisel-pointed, in order to pry out the dogs more handily. The head is made of steel or of oak bound by steel bands, and the total weight of the maul is about 10 pounds.

Another member of the crew whose equipment should be touched upon is the line-horse. As he is guided wholly by the voice, the only headgear necessary is a halter. The rest of his harness is very similar to the ordinary hauling harness, with the exception of the chain which is wrapped around the cable. This is attached to a ring in the middle of the single-tree and is made of small links with what is known as a "grab-

hook" at the end, this being merely a hook which is curved straight back, so as to form a straight slit. When the grab-hook is put over one link, it comes up against the next and is held fast.

A rather ingenious variation is the patent line-horse grip in use at a number of camps. It saves the line-horse man much time, since he has only to put the cable in a groove in the grip and when the horse starts the grip is turned in such a way as to pinch the cable and hold it fast. In other respects there is little variation from camp to camp in the harness of the line-horse.

The cost of a line-horse might be put roughly at about $75. Livery stable horses can be bought for about $40, while horses for a regular logging team cost as much as $500 a pair. Line-horses are usually superior to the ordinary stable horse, but are not so strong or so heavily built as the logging animals. A combination of willingness, strength, and ability to get round in rough country seems essential for a good line-horse.

YARDING ENGINES

The yarding engines now in use at the different camps in the State of Washington do not at first sight present many striking differences in construction. To the casual observer they would all seem to consist of a boiler and a drum on which to wind in the cable, this machinery being set on a frame bolted to a heavy sled, with large solid runners made of logs. And, in a rough way, this description would apply to most of the yarding donkeys now in use. Nevertheless, even as there has been a gradual change from oxen to yarding engines, so in the construction of the yarding engine there have been marked improvements of different kinds. From the first single-cylinder, spool donkeys of some twelve horsepower to the latest engine of sixty horsepower, is a long step.

The increase in power is not, however, the only improvement that has been made in donkey construction. Marked changes may be seen in the various ways of winding in the cable, the best method being that which causes the least wear on the line. And in the choice of a yarding donkey this latter consideration is a very important one. A good donkey should have the following qualifications: It should have sufficient power to yard in heavy logs at a fair rate of speed; it should be built strongly enough to stand the racking and strain; it should be able to handle itself, that is, to haul itself round the woods easily; and lastly, it should save the

cable as much as possible. There are, of course, other desirable qualities, such as the ability to yard at short range, but those mentioned above are perhaps the most important.

Instead of describing the many different yarding engines fully, it seems best to take up one type and to give afterwards some idea of the variations from it. The engine to be described as typical is a nine by ten inch double-cylinder, single drum, yarding donkey, the 9 referring to the diameter of the cylinder, the 10 to the stroke. There are so many engines employed which are built in much the same manner, if not of the exact dimensions of the one specified, the writer feels justified in taking it as a type. It has an upright boiler some three and a half feet in diameter, and seven or eight feet high, made of 60,000 T. S. flange-steel, and containing between 80 and 100 2-inch tubes, about 5 feet long. The boiler is tested to 200 pounds cold water pressure and guaranteed to carry 150 pounds steam. The boiler is set on bars across a frame which is made of either steel or cast-iron. Two horizontal cylinders drive a crank shaft with a pinion six to seven inches in diameter, which is geared to a bull wheel or gear wheel about forty-eight inches in diameter. The proportion of the gearing varies a great deal, running from five to one to eight to one.

On the main axle, which turns with the gear-wheel, is the drum on which the cable is wound. Ordinarily the drum allows the axle to revolve freely inside it; when, however,

the engineer wishes to wind in cable, he forces the drum against the "friction" at the end of the axle. The friction, which is usually made of oak, is a sort of rim which fits into the shape of the drum. When the drum is forced against it, it is gripped so tight as to turn with the gear-wheel, yet, being held merely by the friction of iron on oak, it will give somewhat when a heavy strain is put on it. If the friction is worn so as not to hold effectively, resin is sometimes used. The drum is set against the friction by a lever. When this is released the drum is pushed back from the friction by a spiral spring coiled around the axle. When the drum is thus released, it revolves freely, and in order to stop it from turning too fast when line is being run out, a brake is put on. This consists of a circular, steel strap lined with wood or rubber, which usually runs on a flat surface outside of the flange. It is worked by a foot-lever where the engineer can control it easily. In fact on some engines, the engineer, without changing his position, can operate the throttle, the brake, both frictions (if there is a top drum), and the top and bottom dampers.

The bottom damper is, of course, under the fire-box at the back of the engine. There is usually another in the smokestack which is opened and shut by a wire. The injectors, through which water is taken into the boiler, are usually three-fourths inch. As to exhaust pipes, some engines have them going into the stack, while in others they exhaust in the

air. Nearly all yarding engines are high pressure. The weight of the latest models runs from 6 to 9 tons, and their cost is between $1,200 and $1,500. Engines of the type described above are still being made in large numbers by one of the two leading manufacturing companies in the State. The other company believes it has invented a yarder with some improvements over this. However, before describing it in detail, it seems best to make some mention of the earlier type of engine used in the woods, and which is still seen in many camps. This engine has but one cylinder (an upright one), and winds in the cable on a spool, therefore requiring a spool-tender. The particular engine represented in the photograph was built in 1892. It has a 6-inch cylinder with a stroke of 12 inches, is geared eight to one and is run at 140 pounds. When it is yarding, the spool-tender takes eight or nine turns around the spool and hauls in the cable as the spool revolves. The chief objections to this form of yarder are that it is not powerful enough, that it requires the services of an extra man, and that it wears the cable rather fast on account of the sharp turns around the spool. Moreover, when the donkey is moved, the line has to be coiled up, which takes a good deal of time. The engine in the photograph had been displaced as a yarder by newer and more powerful engines, and was used chiefly for building skid and railroads, its work consisting of "chunking" out "right of ways."

The next type of engine evolved was more powerful. It had two horizontal cylinders instead of one upright, and a

drum instead of a spool. There was also a marked increase in the size of the boiler. The resulting advantages were greater speed, less wear on the cable, and the employment of one less man, the spool-tender, although at some camps his place is taken by a drum-tender. Two disadvantages of this type of engine were that when yarding for a long distance, - anything over 700 feet, - it lost considerable power through the piling up of the cable on the drum, and that if the line did not play straight it wore itself out quickly. Another result of using a drum was that the first lead had to be set exactly in front of it and at some distance away, else the line would not play straight. The distance between the drum and the first lead varies according to the width of the drum, the narrower the drum the shorter the distance. To give more exact figures a drum 36 inches wide requires a lead of about 40 feet.

Some of the donkeys of this period avoided these disadvantages to some extent. In order to keep the power the same, however, much cable was being wound in, recourse was had to a horizontal spool from which the slack was taken by a drum behind it. All the strain came, however, on the spool. This arrangement prevented any piling up and also made it practicable to have the first lead on the sled itself, instead of being some forty feet away. The narrowness of the spool insured the lines playing straight even when coming from such a short distance between the two rollers on the front of the sled. On the

other hand, the sharp turn around the spool was injurious to the cable. The addition of the spool also meant a good deal of extra machinery and in an engine that has to rough it in the woods, simplicity is essential.

To overcome some of these faults an engine was designed having such a large drum that there can be no sharp turn, and the coiling up is so slight that the power of the donkey is not materially affected even when there is 600 feet of seven-eighths inch cable piled up on it. By having a narrow drum this engine retains the other desirable features of a spool donkey, the ability to work with a short lead. These engines are made with drums either 30 or 40 inches in diameter, according to the wish of the logger. The roller resting on top of the drum is called the "idler," and is to keep the line from springing. The drum, which is balanced like a pulley, runs on roller bearings and is easily turned by hand. The manufacturers claim for this donkey that it can yard more logs with the same cable and rigging than any other make of yarding engine.

Besides these variations in yarding donkeys, there are numberless small differences. One invention is known as the turn-table engine. It is made like other yarders with the exception that it is placed on a circular frame and can revolve and yard from any direction. Theoretically this is a great improvement; in practice, however, the writer found that most of the turn-table engines in use in the woods were either clamped

or bolted down, so that the engine could not revolve. The objection to them is that, with such an insecure foundation, the jarring racks the machinery too much, and that when it is yarding to one side, there is always the danger that a sudden break in the rigging will topple the engine over sideways.

Another rather uncommon device is a small engine and drum situated on the rear platform of the donkey, obtaining its steam from the main boiler. This is used to haul out the cable from the road engine on the landing. By the employment of this device, a road engine at one camp seen was enabled to haul from two yarders. Another logger found it attended by this disadvantage: It necessitated a very sharp turn at the first lead behind the donkey, because with the donkey set quartering on the skid-road, the haulback-line had to make such a turn before it could go through a lead on the skid-road. It obviously requires more steam to run both engines. One compensating advantage over the use of an ordinary haulback-line on the road engine is that only half the length of line is necessary. It also leaves the top drum of the road engine free for a loading line.

Minor differences come also in the arrangements of the top and bottom dampers, and of the exhaust pipes. The top damper is usually regulated by a wire convenient to the engineer. On some donkeys there is a lever close at hand by which he can open and shut the bottom damper. On many, however, there is no bottom damper, so the only way to regulate the draught is to

block it up with logs. As to the exhaust pipes, they may enter the stack or discharge into the air. A third arrangement has one go into the stack, the other into the air. In some cases it is found that when both lead into the stack, they create too strong a draught. A few engineers who have the exhaust pipes going into the smokestack during the rainy season, take them out during the summer on account of the danger of sparks setting fire to the woods.

One of the most important differences between the donkeys made by the two largest firms in the State lies in the way the frame is built. To quote from the circular of one company concerning its standard solid frame yarding engine: "The engine frame, including the two shaft bearings, is cast in one piece and is made sufficiently strong to withstand all the strains to which a logging engine is subject. Engines always in line. No multiplicity of bolts to look after, and all bolts in plain view of engineer. Bearing bolts have double nuts."

On the other hand, manufacturers of engines with steel frames say their engines also stay in line, and claim the fact that the frame is bolted together, renders it a simple matter to replace any part that may be broken. The choice between the different makes seems to be largely a matter of habit; loggers accustomed to using the donkeys of one company are apt to be satisfied without much investigation of other kinds.

The sled on which the donkey rests consists of two large runners made of logs, bolted together and covered fore

and aft by a platform. The donkey is put on these runners as follows: It is jacked up, first on one runner and then the other, about in the middle of the sled. Then heavy braces, some 18 inches by 8, one in front of the engine and one behind it, are notched deep into the runners and spiked, after which the donkey frame is bolted down. Holes are then bored in the runners for three iron rods, one at each end and one in the middle, which are put through and bolted on the outside. These keep the runners from spreading. Then heavy planks are nailed on for the platform. Loops of cable, on which to hang blocks for the line to pass through when the donkey is yarding at short range, are made by passing a short piece of line through holes in the front and back ends of runners. On certain makes of donkey, two upright rollers for the line to pass between are set on the front platform. When the cable is first put on the drum it is very important to have it wound tight and straight, otherwise it has a tendency to run crooked. After the cable has been wound, a footboard is usually put on the side of the sled, for the engineer to stand on. It is also rather common to see a roof put over the donkey, supported by upright posts in the corners and usually made of split cedar shakes or corrugated iron. The size of the runners depends on the size of the donkey, varying in length from 25 to 32 feet and in thickness from 14 inches to 2 feet. Donkeys that work on rough ground have rather heavier sleds than those used on smooth and level ground.

After the donkey has been set up and is ready for work, it has to be moved to its setting. If this is on a skid-road, the engine hauls itself along by taking a tail-hold on some tree ahead and winding in the cable. When going down hills it may be snubbed by the cable of the road donkey, which keeps it from going too fast, or, if the road donkey is not near by, it may be let down by a line wrapped two or three times about a tree. If the donkey is to be moved along a railroad track, it either handles itself as on a skid-road, or is hauled on logging trucks. When it reaches its "setting" - a cleared space along the track or skid-road - a "tail-hold" is taken on some tree or stump behind to keep the donkey in place when it is yarding. In this case, a tail-hold means nothing more than a short piece of cable made fast at one end to the loop in the rear end of the runners, and at the other to some immovable object.

The usual number of men to a donkey is two, an engineer and a fireman. For donkeys using a spool instead of a drum, there is a third, the spool-tender, whose business it is to handle the cable as it is reeled in on the spool. At some camps there is a drum-tender, who sees that the line plays straight on the drum and prevents it from piling up. When the donkey is set where it is hard to get fuel or water, there may be an extra "flunkey," as he is usually called, to "pack" water or buck up wood. Curiously enough, at most camps the fireman does not fire up the engine in the morning. This is done by

the engineer. He usually leaves plenty of water in the boiler the last thing in the evening, so does not have to put in much at the first firing. After starting his fire, he usually closes the draught and lets it stand until work begins.

When work has begun, the fireman attends to the firing as the engineer's time is fully occupied. When the line is first run out to the woods, he has to keep an eye on the drum, sometimes using the brake to prevent the line from going out too fast. When it has been run out he keeps a sharp watch on the signal-man, and, if he receives the signal to go ahead, puts on the friction and opens the throttle. When he is given the signal to stop, he may also be told to "hold her," in which case he keeps the friction on. If the log sticks badly, he turns on full steam, as the ordinary yarding engine seems capable of standing any strain. After he has yarded in a log, he may have the engine fired up to within a few pounds of what it can carry (usually 140 pounds), and then turn off the damper and blower. In places where water or fuel is hard to obtain, this is particularly important, since any waste of steam means more work for the fireman and possibly the employment of an extra flunkey.

In the meantime, the firing and watering is being attended to by the fireman. As a rule, he keeps his glass about three-fourths full, taking water when necessary, through the injector, from barrels behind the donkey. Sometimes instead of barrels, there is a small tank. The fuel usually consists of

fir bark; or when this is not obtainable, of wood. The amount used in a day varies from half a cord to a cord and a half, depending on the size of the donkey and the work it has to do.

Wood is more easily obtained than water. The amount of the latter required by an average yarding engine, doing a fair day's work, is from eight to fourteen barrels of 52 gallons each. As the yarding donkey is quite often set on the skid-road over a half mile from the road engine, the problem of carrying water to it may present difficulties. The usual method consists in filling barrels at the road donkey on the landing, and hauling them out along the skideroad on a water-sled which goes out with the cable. Where the skid-road is too precipitousm this method is impracticable and the engineer has to get water from some source in the woods. A common expedient is to set a hand pump by the nearest creek, which may necessitate the use of 1,000 feet of pipe. Another method is to carry water in canvas sacks on a horse. In a word, the manner in which the donkey is watered depends largely on the natural conditions.

Although as a rule, only two men are absolutely required for the running of a yarding donkey, there are sometimes as many as four. In addition to the engineer and fireman there may be a spool or drum-tender and a flunkey to cut wood or carry water. The most important one is, of course, the engineer. In some cases he is a trained mechanic who has either worked in machine shops or run some other kind of engine, while in others

he has picked up his knowledge of engines while working in the woods. The first type of engineer has a great advantage over the second in that he is more capable of repairing any damage to his engine. Nevertheless, in looking after the engine and in preserving the cable, coupled with quickness in obeying signals, seems in some cases to more than offset a mechanical training. Quite frequently men who have had no experience with engines before working in the woods, make very efficient engineers.

The engineer's wages are among the highest in camp; ranging from $2.75 to $3.50 a day. A fairly common arrangement, is for the donkey engineer to receive so much a month and board, usually not far from $60. As board is from $4.50 to $5.25 a week, this means very fair wages. A working month is usually estimated at 26 days. Any time that an engineer puts in over this, such as repairing his engine on Sundays, he is paid for extra. On rainy days he is supposed to fire his engine on the chance of its clearing up. At some camps he receives 25 cents for firing in the morning and as much again at noon; at others he receives half a day's wages.

Between the wages of the engineer and those of the fireman there is a great difference; the fireman usually being paid but little more than the skid-road men, who, with the possible exception of the camp flunkey, are the lowest paid in camp. The fireman's wages range from $2.10 to $2.35. When bark is easily obtainable, he is apt to use it instead of wood.

If the water is brought to the donkey on a sled or otherwise, his watering consists of little more than putting the injector hose in the barrel. Sometimes however, he not only has to buck up wood and look after his fire, but has also to help in the pumping.

The spool-tender is rather less important to-day than he was a few years ago, when spool-donkeys were more extensively used. It used to require some skill and experience to look after a yarding cable, to coil it up properly when the donkey was to be moved, and to keep it clear of kinks. What little spool-tending there is now, is done mainly on ex-yarding engines that are being used in such work as the construction of skid-roads, or else on the loading spool of a road engine, nor are drum-tenders employed very extensively. Their duty is to keep the line playing straight, and to prevent it from piling up, which they usually do with a small iron bar called a "pinch-bar." At many camps the drum-tender is thought unnecessary and the engineer himself attends to the cable, knocking it into place with a small hammer when it begins to pile up. Drum-tending is rather dangerous, especially if the drum-tender does not take care to stand outside of the bight, when the log has been yarded close to the engine. The writer has seen two drum-tenders knocked unconscious, one of whom escaped serious injuries only by receiving the brunt of the shock on the pinch-bar which he held across his chest. In one case the dogs pulled out, in the other the line broke. With a careful engineer, who does not take chances when

the log is near the engine, there is not much danger. The wages of the spool or drum-tender are from $2.25 to $2.45.

Of the accessories of a yarding engine, the most important is the cable. For yarding, this is almost invariably made of plough-steel, usually three-quarters of an inch in diameter, although seven-eighths is frequently used for large timber and one-inch has sometimes been tried. They are commonly made of six strands of nineteen wires each, wound about a hemp center. To quote from the catalogue of one wire company, "John A. Roebling's Sons Company" -

> "Plough steel wire is made from a high grade of crucible-cast steel, and will stand a strain of from 95 to 175 tons per square inch, according to the variety of steel used, the size of wire, and the method of manufacturing and improving the wire...... Plough steel is, therefore, applicable to conditions involving great wear and rough usage. It is advisable to reduce all bends to a minimum and to use somewhat larger drums and sheaves than are suitable for the ordinary cast steel rope, having a strength of 60 to 80 tons per square inch."

As a rule, plough steel is used for yarding, while crucible is employed on road engines where it would not have to stand such rough usage. According to the catalog quoted above, the strength of crucible steel ranges from 130,000 to 190,000 pounds per square inch, and plough steel from 190,000 to 350,000 pounds per square inch, according to quality, treatment, size of wire, and so on.

Yarding requires the toughest of steel cable; even the best plough-steel does not last very long. It is impossible to state with any accuracy the life of a yarding cable, as

so much depends on the care that is taken of it. A cable that plays straight on the drum and passes through large sheaves on sharp turns, would probably outlast one that was allowed to pile up on the drum, and in other respects was not carefully looked after. A common estimate, however, for the life of a yarding cable, is 1,500,000 to 2,500,000 feet of logs. In the case of a donkey yarding 50,000 a day - a rather high average - the cable would then last somewhere between 6 weeks and 2 months. The writer has heard of cables lasting to take out 4,000,000 feet of logs, but not on entirely reliable authority. Assuming the first estimate to be roughly correct, with seven-eighths cable at 22 cents a foot including discount, the cost of yarding cable would be rather greater than .06 for a thousand feet of logs. It is apparent that it is worth while to look after the cable with some care. In the first place, it should be wound tight and straight on the drum. If it becomes badly kinked, it is generally wound on again very carefully, being held taut by having a turn or two taken around a stump.

The size of the drums and sheaves also has a good deal to do with the life of a cable. Some instructive tables regarding the minimum sizes of drums or sheaves for cables of various diameters, have been made out and printed by wire manufacturers. Of course the larger the drum or sheave, the better for the cable, but for practical purposes the use of sheaves much larger than 8 inches, is barred, as far as yarding blocks go, on account of

the weight of the blocks. Another factor in the life of a line is the application of lubricants, not only to keep the wire from rusting, but to prevent the hemp core from getting dry and breaking. Rather curiously little attention is paid to this method of preserving cable, and the ordinary yarding line is seldom oiled. At one camp where it was kept well oiled, the foreman attributed largely to this lubrication the fact that it had lasted him for over 3,000,000 feet of logs.

The length of the usual yarding cable is about 800 feet, although 600 feet is as far as most loggers care to yard. At some camps 1,000 feet of line is taken on the drum, an increase chiefly due to the fact that in some mountainous districts it is impracticable to have the skid-roads close together. Even when the logger does not propose to yard far, he has his cable somewhat long in order to have some extra line for getting block purchase. When the cable is worn out for yarding it is by no means wholly useless, as it is generally saved for some lighter work. After it has once started to break, it is spliced together again and used until the breaking becomes so frequent as to be not only dangerous, but unprofitable.

Of the other accessories of a yarding donkey, some of the most important are those which have to do with its water-supply. As has been stated, the water is commonly brought in barrels hauled on a sled from the road engine. The sled is usually boat-shaped, and consists of boards laid across two runners sometimes curved to a point in front and sometimes parallel.

They hold as a rule from six to nine barrels. A force-pump operated by two men is used quite frequently, and water is pumped sometimes to a distance of 1,000 feet, with a rise of 100.

The placing of yarding donkeys to the best advantage depends largely on the nature of the country and the method of hauling, and is a matter that requires much judgment. Few loggers like to yard farther than 600 feet; in such cases, the distance covered by the skid-roads would not exceed 1,200 feet at the outside. In level country the logger can generally carry out some preconceived plan in the arrangement of his roads, but in a rough country, or where a locomotive has been substituted for a road engine, he may be unable to keep to any set scheme and will have to run them wherever he can.

The nature of the ground would not, however, have much to do with the relation of the donkey to the woods crew. At some camps the logger tries to keep the fallers one setting ahead, and to leave the donkey crew perfectly free; at others the donkey will be working on the heels of the woods crew. If the woods crew are one or two days' work ahead of the donkey, they are not apt to work as hard as if the donkey were close behind them, but, on the other hand, the donkey is always sure of having enough logs to yard. When all the men are pretty well bunched there is little chance of any shirking, but to offset this there is the possibility that the donkey will overtake the

woods crew and have to wait for the logs. To this should be added the inconvenience of being forced to stop work and having to shift about in order to avoid trees that are being felled. The chief argument against the employment of the first method consists in the chance of losing something on the men's work; that against the use of the second, in the possibility of losing rather more by the enforced idleness of the donkey crew. As unexpected obstacles may arise, such as a number of pitchy trees or of trees that require wedging, the woods crew is usually somewhat larger than is absolutely necessary to supply the donkey.

HAULING WITH HORSE-TEAM

An account has been given of the passage of the log from the stump to the yarding donkey. Next to be described are the various ways of hauling the log to the landing, as by horse-team, road-engine or locomotive. Hauling by oxen is very similar to the same work performed by horses. In a general way, it may be said that there has been a progression from horse-team to road-engine and from road-engine to locomotive. This statement must be taken very broadly, however, as, to give a specific instance, at camps run by the same company, and within a few miles of each other, all three methods may be employed. Perhaps the most common way of hauling throughout the State is by road-engine, the locomotive being substituted for it by only a few of the larger and more progressive companies. Horse-teams are however, still in common use.

A full horse-team consists of five spans, although sometimes teams of four, six, or eight horses are used. In the description of yarding by horse-team, the fact was mentioned that the same team sometimes does both the yarding and hauling. Although this is not uncommon a combination freqnently found is a horse-team hauling from a yarding donkey. At one camp seen by the writer, where there was a long haul, a horse-team took the turn for about a mile and there handed it over to a road-engine.

The general scheme of hauling is readily apparent from the photograph. Three, four, or five span of horses are attached to a steel cable, usually called the "lead-line," which runs between them back to the last spreader; this is hooked into the "head-chain," which is the chain "crotched," i.e., dogged into both sides of the head-log. The other logs making up the turn are coupled together, either by dog or grab couplings, which are short pieces of cable joining the hooks, one of which is driven into the end of the log, the other into the log next it. When the team and turn arrive at the landing the logs are hauled where the loaders wish them, the couplings are taken out and thrown onto a chain-sled fastened to the spreader hook and the team is ready to go back for the next turn.

A turn is made up in much the same way for horse-team, road-engine, or locomotive. The "head-log"--the front one--is usually the largest, and is also one that will "track" well, that is, lie flat and stay on the ride. If the head-log keeps on the ride, none of the others can roll over unless a coupling comes out. The others decrease gradually in size, the smallest coming at the end.

The size of the turn varies considerably from camp to camp, depending on the distance to be hauled, the number of horses in the team, the size of the logs, and above all, on the grade. If there are many steep up-grades, the use of a

horse-team is practically barred. Speaking roughly, in average conditions a turn does not contain much less than 4,000 feet. It is then apparent that skidding for a horse-team is rather different from skidding for a road-engine. In the first place, the road for horses should never have a grade steeper than four per cent and if the skidder is able to avoid a grade by making a detour, he usually does so. In roads where a bad grade has been put in, the teamster separates his turn and makes two trips. Besides the question of grade, there are other important differences between skidding for road-engines and doing it for horse-teams--one is the use of "puncheon," that is, planking or corduroy of some sort put across the road to make better footing. Even when puncheon is used, the roads are apt to become pretty muddy, so that many horse-team camps close down during the worst part of the rainy season, that is, roughly, from December to March.

The number of horses to a team varies from camp to camp; for hauling from a yarding-donkey ten are usually thought necessary, although on a steady down grade six may be sufficient. At one camp where a 10-horse-team was hauling a little over 900 yards from a yarder, the time for taking in a turn of two large logs, scaling together about 8,000 feet, was 13 minutes, for going back, on a slight up-grade, 15 minutes. Of course, the longer the haul, the fewer the turns that can be taken in a day. A team seldom hauls more than a mile, at which

distance a very fair day's work would consist of six turns of 5,000 feet each, or 30,000 feet altogether.

A good teamster will not let his team be injured by hauling too heavy a turn. For the same reason, he usually lets the team walk at the pace of the slowest span. The leaders, of course, have to be as strong and willing, if not more so, than any other span. The span next to the log are called the "butts" and those between them and the leaders are known as the "swing teams." A team is naturally more effective after working together for a while than when the horses are unused to each other. One of the best teams the writer has seen has been working together for four years. The owners thought, with proper care, they should last another four. At some camps the care of the team devolves on the teamster and skid-greaser, who clean them either once or twice a day--in the morning, and usually in the evening--while at other camps they are looked after by the stable-boss.

The harness for horse-teams is much the same at all camps except for small variations in such details as traces and neck-yokes. The harness for each span is complete, so that any pair can be cut out. Two chains or rods run back from the ends of the spreader, or double-tree, to a ring. The cable or "lead-rod" is coupled to the ring by an open link, and fastened to the back of the ring is the spreader-hook. To connect the span with the one behind, this spreader-hook is hooked into the ring

at the front end of the lead-rod, which hangs from the neck-yoke of the next span. To still further support the lead-rod, there are usually leather straps under it, running from the inside trace of one horse to that of the other. In order to cut out a span all that is necessary is to take out the spreader-hooks. The reins are disengaged by snaps. In some camps reins are dispensed with, the horses being guided entirely by voice.

Occasionally a tongue is used, one end of which is dogged into the head log, the other being hooked to the lead-rod underneath the spreader by a pig-tail. The object of the tongue is to keep the head log from fouling the rigging on down grades. At some camps such accidents are guarded against by the employment of a long piece of cable, so that on down grades the horses are well out of range of the turn.

The cost of a good span is from $400 to $600, the harness costing some $50 more. Board ranges from $10 to $13 a month, a piece. At the latter figure, about $8 is allowed for oats and $5 for hay; this, however, is perhaps rather higher than most loggers are paying. At this rate, the cost of boarding a 10-horse-team for a year would be about $1,450. The men employed about a horse-team are two in number, a teamster, and a skid-greaser who precedes the team and oils the skids. A good teamster can command top wages. At one small camp seen by the writer, where the foreman was receiving $80 a month and board, the teamster received $100. When a stable-boss is employed he seldom gets much more than skid-roadmen, or between $2 and $2.35.

HAULING WITH ROAD-ENGINE

A road-engine may be roughly described as a yarding-engine built on a large scale. Its duty is to haul the logs from the yarder to their next destination, usually the landing. The maximum hauling distance might for practical purposes be reckoned a mile, although some of the largest engines have room for a mile and a quarter of inch cable.

Perhaps the best way to describe a road-engine will be to state wherein it differs from a yarding-donkey. The arrangement of the boilers, fire-box, frame, gearing, and drums is practically the same; the most noticeable differences come in the increase in size and power, and in the use of two drums instead of one. The top drum is for the return, or "Haul-back" line, of five-eighth inch cable, which runs through a trail-block close to the yarder and back to the road-engine. Road-engines, like yarders, are built in all sizes, from 7 by 10 to 10 by 15 inches, weigh from 8 tons to 15, and range roughly from 30 to 70 horsepower. The boilers arefrom five-sixteenths to one-half inch thick, although three-eights is seldom exceeded. Most of them are guaranteed to carry 150 pounds, but 100 pounds is the usual working pressure. Nearly all are high pressure engines, although the writer has seen one or two compound. When working steadily, the average road-engine uses daily from 1-1/2 to 2-1/2 cords of wood, and from 15 to 25 barrels of water

holding about 50 gallons a piece. The boilers are some 5 feet in diameter by 8 in height and contain as many as 225 2-inch steel tubes. The gearing is usually about 6 to 1.

The most striking variation in the drums is in their greater width and increased height of flange. As has been stated, some of the larger engines have room for a mile and a quarter of 1-inch cable on the main drum, and for double that length of five-eighth haul-back line on the top drum. One noticeable feature of most road-engines is a spool on the outside of the main drum, which may be used for loading. Another variation from yarding-donkeys, occurs in the method of putting on the friction. In many cases there is the usual friction lever, which is held down by the engineer's weight but in others, the lever is displaced by a wheel which screws into the end of the shaft, and revolves with it To take off the friction it is necessary to stop the engine. The two advantages of this scheme are first, that it makes the engineer's work easier, as all he has to do is to set the wheel, instead of being forced to hold down the lever; and, second, that it does away with the wear on the pin which presses against the key going through the shaft and keeps the drum in place. On the other hand, several engineers prefer the lever, as they can "feel" the engine and the lever is much handier and quicker for work on the landing.

Let us assume that the road-engine has been set at one end of the landing, with the yarder out on the skid-road

three or four thousand feet distant. Before the engine can begin work, the haul-back line has to be set up. This is run out through the woods by hand, the men who carry it taking as straight a course as possible to the yarder, and putting the line through small blocks fastened to trees. Close to the yarding-donkey a "tail-block" with a sheave of ten or twelve inches is set up, and the haul-back line is passed through it. Then it can be fastened to the cable as soon as that has been run out by the line-horses.

The turn is usually made up by the man who is tending hook for the road-engine, and who goes in with the logs, usually on the rigging-sled which is dogged to the last one. This is made like a water-sled, but rather lighter, since it has only to bear the couplings. As a rule, the hooktender has nothing to do going in; sometimes, when there is a chute or a steep place channeled in the earth, at the top of the slope, he may have to take the line-hook out of the head-chain, and put it in again at the bottom. This is comparatively easy even although the line is taut. The line-hook is at the end of a "tail-piece" some twenty-feet long which is fastened by a swivel to the same ring that the haul-back line is hooked into. So, although both the cable and haul-back line are taut, the tail-piece and line-hook swing from the ring and can be handled easily. When the turn has been hauled to the landing, the hooktender takes out the couplings

and helps to "mate" the logs, or get those of equal lengths in the same tier. If the donkey is set by the river, he simply takes them out and waits until,the donkey has bucked in the turn into the water. Then he throws the chains on the sled, fastens it to the line-hook, and tells the engineer to go ahead. The signals, by-the-way, are given from the woods by pulling on a wire running out along the skid-road and fastened to the whistle or to a bell set close to the road-engine.

The turn which a road-engine takes varies considerably according to the size of the engine, the grades, the length of the haul, and so on. Where it is possible to keep a set method of skidding, the logger, unless he owns one of the larger engines, does not build his skid-roads much longer than 3,000 feet. Of course, the longer the haul the more friction there is around turns, but this is a small factor in the increased work of the engine compared to the coiling up of the cable. The difference between hauling with a drum a foot in diameter, and with the same drum after 4,000 feet of 1-inch cable have been coiled on it it almost enough to offset the effect of the gearing. Of course the hardest part of the haul comes when most cable is piled up, that is, near the landing, so a down grade there is of great assistance. If there is a hard upgrade near the engine it may necessitate small turns. The largest turn which the writer remembers was one of four logs aggregating 11,000 feet, which was hauled about 2,800 feet, mostly down grade, in 4 minutes and 45 seconds by one of the larger engines.

The chief complaint, or one of the complaints, made against the smaller engine is that they get out of breath on long hauls, a defect due principally to the small size of the boilers.

Something has already been said about the usual disposition of road-engines, that is, of their being set on the end of a landing and hauling from one yarder in the woods. A different arrangement is that where a road-engine hauls from two yarders, one on the main road, one on a branch. Instead of a haul-back line on the road-engine, there is a drum with a return line on the back of each yarder. When a turn is coming in from one yarder, it is stopped at the fork, and the haul-back line of the other one fastened to the cable. In this way the road-engine alternates from one to the other.

Another arrangement, known as a "battery," has two, and sometimes three, road-engines set along the skid-road, each one hauling the turn for some 4,000 feet and handing it on to the next. The great drawback to this scheme is the cost of cable and it is seldom resorted to if any other scheme such as running in a railroad to a new landing, is practicable.

Some loggers use small road-donkeys for yarding and hauling, both. The engine is set at the end of the landing, from which skid-roads radiate in a half-circle for a distance of about 1,300 feet. The skidding is close, there being not more than 500 feet between the skid-roads. The donkey yards out a turn and then hauls it in, averaging a little better than

30,000 feet a day. One advantage of this scheme is that it saves the use of one donkey. With the usual yarder and road-engine working together, the total output for both is some 45,000, or 22,500 a piece. By this arrangement each engine takes out 30,000. On the other hand, there is an increase in the cost of skidding. Another advantage resulting from the use of this method is the saving of timber. As a rule, the fallers take all the trees they are going to, at one cutting. If the woods crew are working on a thick stand, they are sure to waste a great deal of timber by falling trees on top of one another. At one camp where this combined yarding and hauling method is practiced, the timber, although rather small, stands very thick. Accordingly, the fallers, after working on one skid-road, change to another and then go back to the first one for a second cutting, and in some cases a third and a fourth, thus saving much timber. As the cable is taken out by line-horses, there is no trouble about setting up or moving tail-blocks, and the donkey can yard easily enough from a dozen different places in the same morning. This is, of course, impossible for the ordinary yarding donkey, which to yard a second cutting, would have to move back to its old setting, a proceeding that would take up much valuable time.

The great drawback to using a road-engine for long distances--the loss of power occasioned by the piling up of the cable--is one that many loggers have tried to get around, but

without much success. One rather interesting failure consisted in the use of what was practically an endless cable from the road-engine to the yarder. In theory this scheme was excellent; in practice, it was a failure for two reasons. First, the inconvenience of moving the tail-block was very great, and, second, no shaft could be built strong enough to stand the strain. This was due to the weight of the wire and the inevitable sagging. When this occurred, the shaft broke. Such at least, is the account of this experiment, given to the writer, but as it is at third-hand, he cannot vouch for its entire accuracy.

Of the accessories of the road-engine,the most important is the cable, or rather cables, counting in the haul-back line. The road-cable is usually of crucible-cast steel, from seven-eighths to 1-1/8 inches in diameter. The commonest size being one inch. Crucible-cast steel is not so tough or so pliable as plough steel, and is less expensive, the catalogue price (subject to discount) of one-inch plough steel being 41 cents a foot, that of crucible-cast, 36 cents. The work it has to do is very different from that required of a yarding cable. It consists chiefly of a straight pull without many turns, or at least turns of any sharpness. The main wear comes not so much from the resistance of the turn as from the dragging of the cable along the skid-road, especially in gravelly regions. At no two camps is the life of the cable the same, much depending on the nature of the soil, the kind of rollers used, and the

care taken of the line by the engineer. A fair average would be about 10,000,000 feet of logs. Calling the amount of cable used 3,000 feet, at about 25 cents a foot, this would make the cost of road-cable in the neighborhood of six cents for a thousand feet of logs. The haul-back line, double the length of the cable, lasts half again as long, costing altogether about four cents a thousand. The estimate usually given for the cost of running an engine, is $100 a month.

From a glance at these figures it is easy to understand why a great deal of attention is paid to the care of the cable. At one camp, the writer saw cables that, on excellent testimony, had lasted to take out from 15,000,000 to 20,000,000 feet. This the foreman considered was due to three causes, the clayey nature of the soil, the substitution of groved rollers for the ordinary flat ones, and the frequent lubrication of the cable. Of course, where the skid-road was greased, the cable was more or less lubricated as it passed over the skids. In addition to this, the engineer made it a practice to pour oil on the cable when it was wound on the drum, with the satisfactory results stated.

In regard to the care of the haul-back line, there is not much to be said. Only the last part of it is hauled along the skid-road. The tail-block, where the line has a very sharp turn, is usually fitted with a 12-inch sheave; the ordinary haul-back blocks have sheaves of from 5 to 7 inches.

As these blocks have to bear very little strain, they are usually very inexpensive and have only a hook, instead of a swivel, link, and hook, like a yarding block. Of the different kinds of haul-back blocks, one of the simplest is that made out of an oblong sheet of one-half-inch steel plate, bent over like the cover of a book. The hook is passed through the back and the sheave turns on a pin which can be taken out by knocking out a small pin which passes through a hole in the sheave-pin outside of the block.

In the methods of watering road-donkeys, there is great variety. When the logger owns a locomotive, he usually waters them from its tank. At one camp, instead of watering direct from the locomotive tank, the logger had movable tanks for the purpose. One of them, 12 feet by 10 by 3 feet 8 inches, was run in on a switch and placed on the landing a few feet from the road-engine. This tank, which remained there as long as the donkey was hauling from that end of the landing, was filled twice a week from another set on trucks. Sometimes water is run to the engine in a wooden trough, or through iron pipe, and sometimes a nearby well suffices.

If the water supply is some distance away, a steam pump may be employed. By the kindness of the manufacturers, Laidlaw-Dunn-Gordon-Company of Cincinnati, the writer is enabled to give the exact dimensions of one pump set on the back of a road-engine. "It is a duplex pump with steam cylinders 4-1/2 inches in diameter, water cylinders 2-3/4 inches in diameter, with a stroke of 4 inches. The steam-pipe on this machine is one-half inch, the

exhaust three-fourth inch, the suction 2 inches, and the discharge 1-1/2 inches. Price of this pump at the present time, fitted with steel rods, is $57. Weight 350 pounds. This pump will make 50 revolutions on each side per minute when doing regular work, and will feed a 100 H. P. boiler."

A pump of similar make, used at another camp, was set in a log about four feet above the creek, from which it was pumping water some 400 feet with a raise of about 60 feet.

An extremely simple and ingenious device for watering a road-engine is employed at one camp where the engine is set close by a creek. It is called a siphon pump and consists merely of two pipes going into the creek, a three-fourth inch one taking steam from the injector, and an1-1/4-inch one coming back to the barrels. The steam pipe fits into a T in the larger one which has its end below the surface. All that is necessary to get a good head of water is to turn on the steam.

The firing is, of course, done by the fireman, but there is often a wood-sawyer who does nothing but cut wood. Wood-sawyers are generally paid by the rick, or half-cord, receiving from 70 to 80 cents a piece. Sometimes two sawyers are needed to keep a road-donkey supplied, but as a rule the fireman and one sawyer can buck up all that is necessary. One road-engine seldom uses over seven ricks, or three and a half cords a day.

HAULING BY LOCOMOTIVE

Under this heading the writer does not mean to include an account of shipping timber on logging cars, but the hauling from the yarding-engine to the landing when the turn is dragged over the ties behind a locomotive. In a word, a locomotive is substituted for a road-engine. This way of using a locomotive is at present rather unusual, but it seems likely to be more generally adopted in the future.

The logs are dragged over the ties, or over planking which has been nailed down to protect them. In the first case the track can be taken up quickly and relaid somewhere else, while in the second it is intended to be more or less permanent. The locomotives used for this kind of work are, without exception, geared engines, and include the three best-known types-- the Shay, the Climax, and the Hisler.

At one camp the general plan of hauling is as follows: Railroad tracks are laid branching out from both ends of the landing and two donkeys are set, one at the end of each track. The locomotive hauls from one to the landing, and then continues up the track to the other. In this way it practically takes the place of two road-engines. At this camp the donkeys have their first setting at the ends of the track, and work in toward the landing, for the reason that working outward would require continual cleaning up of the track. At the places where the donkey yards logs on to the track, the latter is protected

by a skid placed outside the rails which lifts the logs over them. After a turn has been yarded out it is fastened to the locomotive by a double cable some twenty feet long, and hauled to the landing where the logs are rolled up on the landing skids, usually by "sheer skids" set in the middle of the track and raised somewhat above the ties. After the turn has been uncoupled, the engineer hauls the logs to any "tier" the head-loader may indicate. ("Tier" is rather an elastic term, meaning any number of logs placed together. For example, on a landing, logs of the same length would be put in the same tier.)

An engine of the Heisler type which was hauling in this way from two yarders, was taking out from 90,000 to 100,000 feet a day. The farthest distance at which it worked was a mile and a quarter, from donkey to donkey. The turns usually consisted of two or three logs scaling between one and two thousand feet apiece. A Climax engine which was used in the same manner, had, according to the owner, hauled from two donkeys, each a mile from the landing. It had taken a turn of 5,000 feet up a six per cent grade, the ties being well greased. The wear on the ties is not excessive, as some are still in use that have been hauled over for three years. In fact, the main wear does not come so much on the middle of the ties as on the ends, which are badly splintered by spike holes owing to frequent moving of the track.

At another camp, where the hauling is done over planking, the locomotive, a heavy Shay engine, hauls from two donkeys,

both set along the same road, which goes up-grade from the landing. The donkeys are set some hundreds of feet apart and are being constantly moved out along the track. One difference between this way of hauling and the other comes in the size of the turns. Hauling from two donkeys and at such a distance, the locomotive necessarily takes larger turns, often dragging six or seven logs aggregating over 10,000 feet. Some of the grades on the way to these donkeys are over eight per cent, which of course are not very difficult for the engine to take without a load.

A locomotive which is hauling between the rails requires the services of three men, an engineer, a fireman, and a hook-tender. The engineers at some camps have formerly run direct locomotives on regular railroads, while at others they have worked their way up from the woods. The lowest wages paid are $2.75, the highest not much over $3.60, or what is about equivalent, $70 a month and board. The fireman receives from $2.40 to $2.70 while the hook-tenders' wages range from $2.50 to $2.70.

Dudleys

Of the different inventions intended to minimize the wear on the cable, one of the most ingenious is that generally known as the "Dudley" engine, which hauls itself along a one-inch steel cable stretched taut from the yarder to the landing. This cable goes between rollers at one end of the platform, passes around a wheel and out again at the other end. It is

gripped to the wheel by holders which open and shut, and when the wheel revolves it moves the engine. The engine is fitted with double eccentrics and can be reversed.

The writer has seen a Dudley made out of an ordinary yarding engine set on a pair of trucks, the total weight being some fourteen tons. For the track, a light rail--about 25 pounds--is used, which is laid on small skids, from 5 to 6 feet apart. At the turns posts are set alongside of the track to keep the cable straight. The engine is run by an engineer, fireman, and hook-tender. When working steadily, it uses a cord and a half of wood and 16 barrels of water. It hauls from a yarder something less than half a mile away, and over grades of more than ten per cent which it encounters when going back empty from the landing. It takes between fourteen and fifteen minutes to haul itself back up this grade. The writer has been told that when the larger Dudley was running, it was capable of going alone up a twenty-five per cent grade and could take a turn of 10,000 feet up a ten per cent grade. At the time of the writer's visit it had been replaced by an ordinary road-engine.

On the whole, the experiment seems not to have proved a success. The Dudleys were much slower than road-engines and seemed to wear out the cable rather quicker, although on this point the testimony was conflicting. One advantage of this engine over the road donkey came in hauling down steep grades. With the latter the line-hook had to be taken out of the head

chain, otherwise the logs were apt to foul the cable, whereas when they were being hauled behind the Dudley, they simply backed into the end of the platform. But taking everything into consideration, the Dudley seems not to have come up to expectations.

LOADING

After the logs have been hauled to the landing, they are loaded on logging-cars, either common flat-cars some 40 feet long, or cars made of two separate trucks which can be moved independently. In general, it may be said that flats are used chiefly when the hauling is done by a railroad company and trucks when the logger does his own hauling. The trucks are of two kinds, high and low, both built on about the same lines except that one is higher and capable of carrying a heavier load than the other. Whatever may be the height of the car, for the purposes of loading the landing is usually made slightly above it, and sloping toward the track. The steeper ones, called "lightning" landings, sometimes have a slope of over 3 feet in 60. Down these landings the logs are rolled on to the cars, to which they are chained. At some landings they are loaded only one row deep, or in a "tier", forming what is called a "bunk-load" (a "bunk" or bolster being the bar, at each end of the car on which the ends of the logs rest). At others they are made into top, or deck-loads, the logs being piled on top of each other.

The methods of loading are extremely varied, depending largely on the kinds of power available. Speaking roughly, they may be divided into two ways: Loading by jacks or peaveys, and loading by a line and hook operated by machinery. Where

the loading is done by jacks, only bunk-loads can be put on, for the leaders have not sufficient power to roll the logs higher than the bottom tier. Where a loading line is used, the logs may be piled up as high as the car will stand or the railroad company will permit. The power at the end of the line may be a pair of horses or a locomotive; or what is more common, the load line may be wound on a spool on the road engine. Sometimes there is a special engine on the landing. In the description of the different methods, loading by jacks will be touched on first and loading by line taken up later.

When the loading is not done by line, either peaveys or jacks are used, peaveys (or sometimes cant-hooks) for small timber, jacks for logs of large size. Four loaders with jacks can handle 100,000 feet a day. There is usually a head loader who superintends the work. He begins by telling the engineer, or teamster, as the case may be, to which tier the different logs in the turn are to be taken. The number of tiers depends on the length of the landing, which varies from 45 to 300 feet. As a rule there is room for at least two tiers each 60 feet long. Each tier contains logs of nearly similar lengths. When bunk-loads are being put on, the logs have to be of nearly the same length, that is, with not much more than 4 feet difference between them, otherwise they would interfere with the logs on the next car. When "reachers" or "roosters", pieces of rail something over 6 feet long and serving as couplings, are used,

there may be greater differences in the lengths of the logs. The loader has in one tier the short logs, that is, those of from 24 to 30 feet, and in the others, logs somewhat longer. He first has the trucks braked down opposite the end of the tier he is to load from. The word "trucks" is used advisedly, for flats are almost always top-loaded--an operation impracticable with jacks. The separate trucks are light enough to be moved by hand and frequently there is a slight down grade from the farther end of the landing where the empties are left. After each has been loaded it can be moved down the track by unsetting the brake.

When the trucks are in proper position, the loader uses his judgment as to whether or not the log is at the right distance from the car to roll on to the "ride." If it is not, he "cuts", or slews, first one end and then the other with jacks until it will roll correctly. Before rolling it up, he has wooden or steel blocks, called "chock," or "cheese" blocks, set on the bunks to prevent it from going on over the car. If the log is a small one, he may roll it on the car at once, but if not, he lets it go merely to the edge of the landing, where it is held by the landing locks. Before knocking these away, he lays a loading skid some 4 feet long and 6 by 7 inches thick from the landing to the car and the log rolls on this skid to the bunk where it is stopped by the cheese-blocks. Sometimes these logs can be put on a

bunk-load. Before chaining them, he usually puts small stone blocks under the sides. In the choice of "binds," that is, the arrangement of chains for bunk-load much depends on the size of the load. As a rule, there are two chains fastened close to the ends of the bunk, which go over the load and have dog-hooks on the ends driven into the logs. If the car is one of a long train and is liable to great strain, an extra chain, called a "backing chain," is used to prevent the trucks from sliding under the logs. This runs from the bunk over the end of one of the logs and is dogged in on top, a similar chain going over the other end of the same log. Then the side chains, running diagonally back, up and over the outside of the logs, are put on and dogged into the log on the farther side. Another arrangement is to have the side chains come up between the logs, simply going half-way around the log, and not, as in the other case, going over the whole load.

Another bind, used on bunk-loads where there is little strain, consists of two long chains which come up over the sides at right angles to the logs, take a half-turn around each other, and then are dogged into the same log, one running back toward the middle, the other out toward the end. Still another bunk-load bind is made by a long chain passing from one end of the bunk over the load through a ring at the end of the other chain, some two feet long, and dogged into the log on the same side as the short chain. Such are some of the varieties of binds used for bunk-loads. When the chains

go over the whole load, the arrangement is called a "top-bind;" when they come up between the logs and merely go over a portion of the load, it is known as a "corner-bind." As a rule a backing chain is unnecessary, as the edge of the bunk is sharp enough to sink into the log and prevent the truck from sliding either way. The bunks are made either of T-rail, or of wood, in which case they have sharp spikes in the top or a piece of rail sunk in which gets a grip on the bark.

The hooks at the ends of the chains may be simple dog-hooks, or what are known as "tail-hooks." The latter are much like dog-hooks except that the hook has a long tail going back from the ring into which the chain is fastened. When the tail-hook is dogged into the log, this tail sticks out some four inches, so that all that is necessary to take out the hook is to hit the tail with a maul. This style of hook saves trouble for the brakemen when they unload.

For work that is seemingly very simple, loading requires a great deal of judgment. The loader has to pick his tier carefully and judge from what distance the log will roll on to the "ride." Besides this, he must have his load well balanced. If it is poorly put on, the brakemen may have the car loaded over again, although with bunk-loads this does not often happen. Putting on top-loads requires rather more judgment than bunk-loading and is also rather better paid. At one camp seen by the writer, where they were loading with jacks,

the head loader received $2.90 and his assistant $2.60. At another camp, where they were putting on top-loads with a road engine, the head loader was making $3.50 a day and the second leader $2.75. This pay was, however, rather higher than is usual where loading is done by line.

The load-line is, as a rule, wound in on a "gypsy" or spool which revolves with the main drum, although when the top drum of the road engine is not being used, it may be wound on that.

In describing top loading an account will first be given of the way in which a car is loaded by a special loading engine. The engine the writer has in mind need not be described in much detail; it is a small 4 by 10 running at 140 pounds and carrying 300 feet of five-eights cable on a 10-inch drum. Instead of the usual friction it works with a clutch. It is set at one end of the landing between the road engine and the track. To hold the necessary leads a log is placed parallel to the rails along the bank on the farther side of the track and slightly above the top of the cars. This is called either a "brow-skid," "draw-skid," or "lead-log." The lead usually consists of a swamp-hook although at some camps wire loops in which to hang the blocks are set a few feet apart along the lead log. At others the leads, instead of being on a log, are set on upright posts something over twenty-feet apart. This arrangement necessitates rather more work for the engineer of the road engine, as he has to haul his tiers just opposite the posts.

However the leads are set, the loader has his load line at right angles to the log. Then he has the car run opposite the tier. If the logs are back from the track, the loader may let them down to the landing blocks with peaveys or jacks, or he may use the load line, at the end of which is a short rounded hook. This is fastened to the "becket," a long sharp swamp hook which is jabbed into the farther side of the log. If it has to be rolled some distance, the line may be wrapped half way around it, the "becket" being hooked into the bottom. The loader then signals to the engineer to wind in. If the log is not at the right distance to come on the ride, he cuts it around by putting in the hook first at one end, then at the other, so as to make the log slide and not roll. After he has taken it down to the landing block; he sets his cheese-blocks, and rolls it on the car. When the bunk is full, the chains are put on and another tier of logs is loaded on top of them. The chains are put on the bottom tier only. When the top logs seem likely to roll off, a short chain may be dogged across them, but such chains are usually unnecessary. Some loaders put blocks between the bottom logs in order to make spaces for the next tier. Others, especially when handling small logs, place them close together.

The logs of the second tier are rolled up on loading-skids, placed one at each end of the car and sloping from the landing to the top of the nearest log in the bottom tier. To

roll logs up this slant, parbuckling is resorted to, which consists of putting the line over the log, back underneath it, and hooking the end to the becket, which is driven into a log on the car. In this way, the loading line is looped around the log and when it is hauled in, the log is rolled up to its place. As a rule, the heaviest logs are put on the bottom and the short logs on top. The greatest divergence possible on cars with ordinary couplings is a little more than 4 feet, but when reaches are used, a difference in length of 8 feet does no harm.

A flat-car is loaded in much the same manner as one made of trucks, except that the bottom tier, instead of being chained, is held by stakes driven into sockets along the sides. The logs have to be mated somewhat more carefully, but, on the other hand, there is little danger of overloading, as most flat-cars are capable of carrying all the logs that can be put on them, or about 10,000 feet. Low trucks seldom carry over 5,000 feet and high trucks are limited by the railroad to 7,500 feet.

There is little practical difference in the various methods of loading by line. When the lead line is wound on the top drum, the engineer has a little more work in attending to both cables. As a rule, he loads only when he is not working with the road cable, although an experienced engineer can look after both at once. When the load line is wound on a spool a spool-tender is necessary. After a little practice, he becomes

expert enough to load while the road engine is on a steady pull; when he wishes to hold a log he lets off a turn or two, so that the spool can turn inside it. In loading with a locomotive, the line is usually made fast either to the tender or to a car behind it and when the loader gives the signal to haul the engineer simply goes ahead. Although this is somewhat slower than winding in the line on a drum, the employment of a locomotive brings with it one notable advantage; the cars can be moved up and down the landing so that logs can be loaded, first from one tier and then from another.

When horses are used for loading, they work on platforms run out some fifty feet on the farther side of the track. In this way they have a straight away pull. Two lengths of cable are used, a long piece for rolling logs down from the back of the landing and a short one for putting them on the cars. Unlessthe logs are below the average size, the loader is often forced to resort to block purchase to put on the top ones. Another disadvantage of using horses is that they are unable to "hold" a large log.

A method of loading similar in most respects to the ones mentioned and yet better in several ways is that used occasionally where there are one-tier landings about 50 feet long and the load line is wound on the top drum. The landing which is on a level with the track, is made of skids laid on the ground with roll-skids sloping up to the level of the cars. The line passes through a block high up on a post at the back

of the landing, and then through one on a post across the tracks. This arrangement is not uncommon. One of the noticeable features is a short piece of cable with an eye-splice in the end, running from the foot of the lead-post across the track. The loader, by putting the line-hook over the log and hooking it into this eye, can roll the log over to the farther side of the car. A similar piece of cable is fastened to the skid on the edge of the landing and runs back beneath the logs. By hooking the line-hook into the eye, a parbuckle loop is quickly formed by which a log can be rolled all the way down the landing. If it does not roll straight, one end is held by a short crow-bar, placed against it like a brace.

For loading logs out of water, various schemes are tried. One consists of running the cars into the water and floating on a bunk-load. Another rather clumsy way is to haul the logs onto the landing end-first, up a small hoist and then load them in the usual way. A more ingenious method is as follows: The loading engine is set a few feet back from the track, on the other side of which are roll-skids sloping down to the water some 8 feet below the level of the railroad. The load line, which is wound in on the main drum, is hooked to a ring at the ends of two pieces of cable fastened to the load-log about 20 feet apart, making a sort of triangular parbuckle loop. By means of this double loop the loaders can roll up long logs for some 12 feet and keep them balanced all the time. The loop

is taken back by a haul-back line, going through leads on a tree in the water and through a block suspended in front of the loading engine. When the loop has been hauled back, the pond-man, standing on a platform a few feet out, can float large logs over it in the right position to be taken up on the roll-skids. The loop can take the logs only to the near side of the bunk, but by the aid of a swamp hook, they can be rolled across. Of course only bunk-loads are put on. The loading is done by the engineer of the locomotive, who also runs the loading engine; two brakemen and the pondman who picks the loads. They can load four cars, averaging 5,000 feet to the car, in forty-five minutes.

As a rule, very long logs are left for the last cars of the train. At some camps, when sticks over 60 feet are being shipped, only one is loaded on a car, on account of the danger of derailing the car on short curves. When long sticks are loaded on "flats," they take up two cars, resting on "false bunks," or skids placed across the ends.

As to the different kinds, it seems scarcely worth while to spend much time on them, on account of the difficulty of giving an intelligent description. A backing chain is seldom, if ever, used, for the weight of the load is usually sufficient to prevent the trucks from sliding underneath it. Most of the chains are dogged in, although some are fitted with pine or grab-hooks. One bind very quickly put on and taken off consists of a long chain noosed by a grab-hook at one end to a ring at one end of the bunk. This is then passed

over the bottom tier and fastened to a fixed link set on the side of the bunk. A flat steel disk at the end of the chain passes through this link and is held there by a captive pin inserted in a hole in the disk. The chain is held taut by the top logs, which puts enough strain on the pin to keep it from coming out. To unload, the brakeman has merely to knock out the pin.

Another bind consists of two chains, one short and one long, which are dogged into the same log, one chain coming over diagonally across the load, the other straight up from the outside. There may be short chains dogged toward the end of the car, with long ones coming up between the logs and dogged on the outside. Another arrangement is to pass one long chain over the load and through a ring, and to noose to itself by a grab-hook. The main thing is to have a bind which will hold and which is handy both for loading, and for unloading.

Of the other accessories of loading, the "chock-blocks," or "cheese-blocks," present the greatest variety. At some camps they are merely wooden blocks, held on the bunk by dogs driven in behind them, and at others they are held by short wooden props braced against the lead-log. Another and rather convenient block has a long link hanging down on each side of the bunk and is held in place by a steel pin which passes through a hole in the bunk and both links. It can be moved along the bunk, since there are a number of holes at suitable intervals. Blocks for bunks that are made of T-rail

are generally fitted to the rail and slipped on over the end. Besides these, there are many other less popular forms of cheese-blocks.

The landing blocks are usually held by stakes going into holes at the end of the landing skids. On some "lightning" landings a hole is gouged at the end of the skid for the block to rest in and the pressure of the logs is transferred downwards by a 3-foot piece of curved rail, one end of which rests on the skid, the other on the block. Putting caulks in the bottom of the block is another ingenious scheme, as it renders stakes unnecessary and gives the block a grip wherever it is placed.

The other implements used in loading are peaveys and jacks; a peavey consists of a long handle with a spike at one end, about one foot from which is hinged a long curved hook; jacks are of three kinds. The sort known as a crank jack, which works with a revolving handle is still in use at a few camps. The chief objection to it is that when working in cramped positions, as under the end of a load, the loader finds it difficult to exert much power. The greater number of camps are using lever jacks of one or two makes, the chief visible difference being that one has a wooden handle, the other a steel one. An objection totthe first kind is that it can take only a full stroke, whereas the steel jack can take strokes of any length. On the other hand, some of the loaders who are using the wooden handled jacks, claim they stand more

rough work than the steel ones. By the courtesy of the manufacturers, the writer is enabled to give the following description of the steel jack: "This jack is made on the ratchet principle and can be worked in any position. It is made entirely of steel, weighs 60 pounds, and with one man on the lever, will lift a dead weight of 8 tons, although the logging capacity of the jack is much more, as in a particularly heavy lift, two or more men can operate the lever, thus greatly increasing the lifting power. This logging jack is built so that it can handle logs of any size, the lifting bar being fitted with a claw which will lift right from the ground. The jack is 22 inches high and lifts 15 inches when bar is raised to its full extent."

Although jacks are employed principally for loading and unloading, they are used occasionally for rolling out logs in swamping when the engine can not reach them, and are also handy for such river work as breaking up jams. When fitted with a low claw they are also useful for such railroad work as lifting rails or ties.

Among the minor accessories are the loading blocks, which are generally fitted with sheaves 5 by 1-1/2 inches. As a rule, they are set on the lead-log, being used merely to get a pull at right angles to the log. Sometimes it is necessary to set an extra one in order to get enough purchase to roll a large log up the loading skids. In this case the block is generally set at the end of a short piece of rigging which is

looped around the log with its under end dogged into one of the bottom logs. The load line which is passed through the block has a tail-hold on the lead-log. Any such arrangement is rare for there is usually power enough without resorting to block purchase.

Another operation which is more or less connected with loading and which is sometimes performed by one of the loaders, is the marking. The marks, or "bands," generally the number of the camp, are made on the end of the log with a short scaling hammer and are so distributed around the edge that one will always be visible, even when the log is in the water. The logger sometimes has separate marks for cedar, for merchantable, and for second-quality logs. At one camp the flooring is given the symbolic mark of a foot. This marking is nearly always done on the landing, sometimes by the company scaler, sometimes by the skid-greaser or one of the loaders.

TRANSPORTATION

After the log has been loaded on the logging car, it is hauled to its next destination, generally a boom situated either on Puget Sound or on a river. Possibly it may be taken direct to the mill. Sometimes it is hauled by a railroad company, sometimes by the logger, with his own locomotive and over his own track. At one camp the logger hauls for a few miles with a geared engine, and then turns the cars over to the railroad company, which is unable to run their locomotive up to his landing on account of the grades.

As a rule loggers do their own hauling only when they are cutting a claim within a reasonably short distance of their boom. Few loggers haul much over 8 miles, although one notable exception is that of a company which has run in a track some 12 miles from its boom. In nearly every instance steel rails are used and the tracks are of standard gauge. At one camp visited the logger was taking up a narrow-gauge track in order to relay it for standard gauge cars. The locomotives employed are of every description, from cheap second-hand 14-ton direct engines to improved geared engines of 50 tons, and the prices paid for them range from $1,500 to $8,000. The rails, which are of every weight from 25 to 56 pounds, are frequently bought second-hand. The ties are obtained as cheaply as possible, being sometimes split out of cedar and sometimes sawed at a mill out of the loggers own timber at a cost of about 9 cents a piece.

The cars used on private roads are nearly always low trucks and are usually made up in trains of not more than 18 cars carrying about 5,000 feet each. As to grades, much depends on the number of empties and the strength of the engine. Locomotives which haul the logs between the rails and have no empties to bring up, can take grades of 12 per cent. On roads where empties are being hauled grades over 8 per cent are generally avoided. At one camp where a geared engine is hauling to the dump, while a direct engine distributes the empties among three landings, 6 per cent is the limit of grade. In order to avoid steep hills a switch-back is sometimes put in.

The speed of the trains also depends on the grades, the number of cars, and the strength of the locomotive; in any case it seldom exceeds 15 miles an hour, a safe rate for jumping in case of accident. This, of course, applies only to private roads. The men employed are an engineer, fireman, and two brakemen who sometimes help in the loading and frequently do all the unloading. Braking on logging cars is always dangerous on account of the inaccessibility of the brakes. On some roads the cars can be braked only by first stopping the train; on others the brakemen are compelled to brake standing between the loads, a very risky position if the train comes to a sudden stop. The different ways of braking will, however, be mentioned later, in the part relating to logging cars.

The locomotives are of both kinds, direct and geared, chiefly the latter on account of their greater adaptability to

grades and curves. The kinds most commonly used are the Shay and the Climax, with occasionally one of the Heisler type. An extremely interesting article about these different types appeared in the Engineering News for December 9, 1897, and those interested in the subject are referred to another article on the Shay engine in the issue for April 26, 1890.

Whatever the type of engine, it is run by an engineer and fireman, except in the case of one or two small models on which one man serves in both capacities. The wood for the locomotives is bucked up and split into logs and piled along the track. As the wood-sawyers receive from $1.40 to $1.60 a cord, the daily cost of fuel for a locomotive burning from 3 to 4 cords would be in the neighborhood of $5. For the average locomotive, however, this would be a rather high estimate. The locomotive is generally watered from a high tank beside the track unless there is a convenient stream. At some camps a rough sort of engine-house is put up, consisting chiefly of a pit and a roof to protect the locomotive from the rain. Several camps which use more than one engine have a large repair shop. On the other hand, when the engine is battered and second-hand, it is frequently left without any protection.

The cars used by most loggers on their own roads are of the kind known as low trucks, whose height from the rail to the top of the bunk varies from 30 to 35 inches. Although they vary in detail, these cars still possess a number

of common features. In general, it may be said that all of them consist of a bunk resting on draft timbers running parallel to the rails and supported eventually by steel arch bars going from axle to axle. Some of these low trucks are manufactured in Washington, but a large proportion comes from Michigan. The dimensions of one car often found in the woods may be of interest. The writer is enabled to present them through the courtesy of the makers, the Russel Wheel and Foundry Company of Detroit.

M.C.B. No. 5 Pattern Logging Car. (Extension Reach.) Specifications - 26 inch Heavy Pattern Wheels, weight 390 pounds each. Axles, M.C.B. Specifications, Journals, 4 by 7 inch. - M.C.B. Pattern Bronze Journal Bearings. - Arch Bars, steel, 3-1/2 by 1 inch, 3-1/2 by 1 inch, 3-1/2 by 5/8 inch. Bolster Truss Rods, 1 inch steel, upset to 1-1/4 inches. - Cross Truck Frames, steel forgings. - Extra Heavy Pattern Castings throughout truck and body. Oil boxes fitted with Hewitt Patent Self-closing lid. - 9 coil 3/4 inch Bearing Springs, 60,000 pounds capacity. Heavy Double Coil Crucible Steel Draft Springs. - all bolts fitted with lock washers - 12 inch steel channel Sand Board. - Selected White Oak timbers throughout. Bunks 11 by 12 by 10 feet. Stringers 6 by 9 inches. Trucks 10 feet over all. Weight 12,200 pounds. Cars made for any gauge required. Special modifications, including M.C.B. Couplers, Automatic Air Brakes, Special Hand Brakes, Patent Bunk End Stakes, Platforms, Tool Boxes, etc., fitted as desired."

These specifications in all their details would apply to a very limited number of cars. In the first place, the bunks vary in length from 9 to 10 feet, and may be either of T rail or wood, the wooden ones being fitted either with a sharp steel edge or spikes or having a piece of rail sunk well in. The frames although generally of steel, are sometimes of wood. The bracing of the bunks is sometimes done by steel rods, sometimes by chains. Occasionally steel rub irons are put under the ends of the bunks. Sometimes the platforms cover most of the trucks, sometimes the middle part, and sometimes there is no platform at all. In the matter of drawheads, there is also diversity; some trucks have them at both ends, while others are clamped to their fellow-truck by short curved iron bars. Spring drawheads are used at many camps, and some loggers have adopted automatic couplers.

The braking is usually done by means of an upright staff, although on many cars, hand brakes are used instead. The wheel brakes on the side, such as are commonly used on high trucks, are not often found on the low ones. It should be remembered that low trucks are built in all sizes, the size and weight of the wheels varying from 24 to 36 inches and from 300 to 390 pounds, while the bearings, to put it roughly, vary from 3 by 5 inches to 4 by 7 inches.

It may readily be understood from these figures why there should be great differences in the sizes of the loads, which run from 3,000 to over 5,000 feet. Where heavy loads

are being hauled at a comparatively high speed - anything over 12 miles - there is of course much more wear on the cars than when hauled at a slower rate. At some camps the speed is regulated by the head brakeman, who has complete charge of the train, while at others it is left to the engineer. For trains of ten cars, there are usually two brakemen; for any more than that, three are generally required.

For down grades, the brakes are generally set while the train waits at the top, although on some hauls they are left half-set all the way. As a rule it is impossible, or at least very dangerous, to set or unset the brakes while the car is in motion. On cars which have upright brake-staffs and which do not have the loads projecting so far as to be in the way, the braking can be done at any time, but at great risk. Instances of fatalities occurring when the brakeman is between two loads are not at all uncommon. A rather ingenious device in use at one or two camps permits the brakeman to do the braking while standing on top of the load. This form of brake consists of a reach of some kind between the two cars furnished at each end with a block which is fastened to the brake-lever. Through these blocks runs the brake-rope, which can be hauled in by the brakeman standing on top of the load. When he releases the rope, the brake-shoes are thrown off the wheels by stiff steel bars. In this way one brakeman can brake two cars and at one camp where this device was used, two men could hold four car loads of about 5,000 feet apiece, on a 6 per cent

grade. At another camp by means of three of those brakes a train of ten cars, with loads of about the same size, is successfully braked down 7 per cent grades by two brakemen and the fireman. The usual arrangement of blocks is to have a double block at one end and a single one at the other. Altogether, this method possesses distinct advantages.

As has been stated, low trucks are seldom used by railroad companies. They usually haul either on high trucks 44 inches from the front rail to the top of the bunk or else on flat cars, from 36 to 41 feet long. In fact, one of the two leading railroads in the State refuses to haul on anything but flats, which can be controlled by the ordinary automatic air brake. In regard to the rates charged by the various roads, the writer can give but a general idea, owing to the constant changes and to the fact that local conditions, such as whether the destination is an inland mill or a boom on the Sound, the grades, the number of feet and so on, have much to do with the cost of transportation. Most of the hauling is done either to the Sound or to a river-boom, and seldom for distances much over 30 miles. For a haul of some 20 miles the rate is in the neighborhood of $1 a thousand, running up to $1.50 for 45 miles. Some idea of the usual distances may be gained from the fact that on one of the large roads, the longest haul is 45 miles. On another road the company charges $12 per load of 7,500 feet, or $1.60 a thousand for hauls of from 54 to 65 miles, a rate few loggers cared to avail themselves of.

Most railroads charge by the scaled foot; some, to avoid any trouble as to scaling, charge by weight, the loads being weighed on an automatic machine near the dump; while others charge by the car-load.

For hauls of less than 20 miles, the rates are extremely variable. On one road the rate is $2 per load of 7,500 feet for the first mile and $1 extra for every succeeding mile up to a distance that would bring the cost to $1 a thousand. As to the rates for shipping to inland mills, the writer is unable to give much detailed information. It may, however, be safely said that the logger who is shipping to an inland mill, most of whose lumber is being sent East over the company's road, is charged less than the logger who is shipping logs to his own boom. Details as to the size of loads may be postponed until more specific mention has been made of the cars. It is, however, a rather interesting fact that for long sticks taking up two flat cars, double rate is generally charged. On one road the rate for a log which projects half over the next flat car is half again as large as the ordinary. Practically all roads require the logger to do the loading and many of them expect him to unload as well. On a few, however, the unloading is done by the brakemen.

There are also some differences in the arrangements made by different roads for running their tracks into camp. Occasionally the logger does the grading and furnishes the ties leaving the company to furnish and lay the rails. One

road makes the logger do everything himself, not only requiring him to furnish the ties and rails, but also to lay the track. The company's contribution consists of sending out men to supervise the laying.

The engines used on these roads are the regular large locomotives found on any railroad. The high trucks are made in much the same way as the low ones, except that they generally have wooden instead of steel frames, and are, of course, more solidly built throughout. There is usually a brake on both trucks instead on one, and it is operated by a wheel on the side. Some of the principal dimensions of the truck used on a well known road are as follows: Height of bunk from rail, 44 inches. Wheels, 33 inches. Width bunk (Trail), 10 feet. As a rule, the limit load for high trucks is 7,500 feet with a penalty for overloading. One road, for example, charges $2 a thousand for any surplus over 7,500 feet.

When the logger is using flat cars he is generally allowed to load as much as he can. Some of these are 36 feet long, but the majority of them are 41 feet and have a capacity of 70,000 pounds. They can, however, be safely loaded 10 per cent over their nominal capacity. They are fitted with wooden bunks, usually some half dozen, and are controlled by air-brakes, a great advantage on grades. Although the flats are not so handy in many ways as the trucks, their comparative indestructibility and the fact that they can be effectively braked on any grade, make it not unlikely that they will supersede trucks on other roads besides the one mentioned. On some

roads the logger is charged for a minimum load of 5,500 feet, and on others of 7,000 feet.

In regard to the advantages of the logger's doing his own hauling, compared with those of having his timber carried by some company, nothing definite can be safely stated. Many loggers say it pays to put in their own track for short hauls; others decide that the initial expense is too heavy. A minor advantage of owning a road is that the logger does not have to keep shifting his camp. One company which has men working 3 miles from camp, carries them out on a sort of passenger car, some 40 feet long. The same company also has a car with a high fence around it for the line horses, which are led up a sloping platform at one end.

While as stated, steel rails are used almost exclusively on these private roads, wooden rails are invariably used on what are known as tram-ways. The tram cars consist of two heavy trucks joined by a solid wooden reach some 21 feet in length. The wheels of these tracts are enormously broad - about 12 inches - and concave so as to fit the wooden rails, which are made of small logs about 7 inches across. The width of the track varies from 6 to 7 feet, but some of the bunks are as broad as 12 feet. The tram-car is hauled by horses, although on down grades it may be allowed to run by itself, being controlled by a brakeman by means of a rope brake, very similar to the one described above. At some camps, it is braked in the ordinary way.

The usual load is a little over 5,000 feet, although the car can carry much more. As for grades, the writer has seen a tram in use on a 15 per cent grade, up which it was hauled when empty by an eight horse team. When the car is loaded, 3 per cent is about as high as is ever attempted. As a rule the road follows the slope of the ground pretty closely, very little cutting or filling being thought necessary. The road can be put in rather cheaply, that is, in comparison with the expense of a railroad. A logger who has used a tram-way for some years estimates that $1,000 a mile will cover everything, including grading and laying. In fairly level country, where the grading is not excessive, the construction of the road is extremely simple. Small logs are sunk in the ground at the proper distance apart, with their ends in the direction of the dump. The ends are cut so as to overlap and are pinned together by 2-inch wooden pegs. The ends are braced solidly, and in moist places are supported by cross-pieces or cribbing.

Tram-ways are chiefly used by small loggers who are satisfied with taking out daily a small amount of timber, that is, not much over 20,000 feet. As a rule they are not built for any great distances, although the whole cost of such a road may be slightly greater than that of a skid-road, more timber can be hauled daily with the same number of horses. On a tram-way an eight horse team can haul 20,000 feet a day for a distance of a mile and a half. The cost of the car is between three and four hundred dollars. Altogether it seems rather strange that

re small loggers who are hauling over a mile should not take
t their timber by this means. At present tram-ways are al-
st as rare as ox-teams in Washington camps.

UNLOADING

After the logs have been hauled to the "dump," which is the name generally given to the part of the track which runs along by the boom, they are unloaded in one of a number of ways. This in itself is a comparatively simple process, consisting of unchaining the load, and rolling it off the car into the water. The best method is that which is quickest, which requires the fewest men, and which injures the cars of the least. Several different schemes have been tried for unloading trucks; flat cars, on the other hand, are all hauled in much the same way.

If the logs are small enough they are usually rolled off the trucks with jacks or peaveys. The track is laid at a slight incline; the top rail being some 4 to 8 inches above the lower. The unloading is generally done by the brakemen, who, standing at the ends of the car, jack together at the same log until they have rolled it off. Two men working this way can unload four cars, each bunk-loaded with between 3,000 and 4,000 feet, in 15 minutes. Top loads offer more difficulty. After prying out the dogs or taking off the grab-hook, as the case may be, the men generally wrap one chain around the inside end of the bunk and underneath the timber below it, so as to prevent the fall of the logs on the other end of the bunk from shaking it loose. Then they jack out the bottom log nearest the dump, which in its fall brings down some of the others. A large log dropping 3 feet onto the bunk is apt to strain

the car and unloading thp loads in this way is not only injurious to the car, but requires several men and a great deal of time. To unload 10 high trucks, with about 7,500 feet apiece, takes eight men about 35 minutes, not counting the subsequent coupling of the cars. A single obstinate car-load may take as much as 12 minutes.

Another way of unloading which is practiced at a few camps consists in holding a short pointed pole some 5 to 7 feet long, with one end on the track and the other against the log, and having the load slowly backed on to it until the log is lifted up sideways into the air and rolled off. This method is especially adapted to unloading cars coupled with long reaches, since these afford the brakemen space enough between the cars to work freely. It is not particularly applicable for long trains, since only one car can be unloaded at a time. At one camp where it is employed, the brakeman puts a solid wooden block some 16 inches high on the bunk to break the fall of the top logs. By the use of the poles, two brakemen can unload nine cars, carrying 4,500 feet each, or 40,000 feet altogether, in 40 minutes.

At some dumps the car is unloaded up the track. At one there are two separate sections of track, each 45 feet long, so that two cars can be unloaded at the same time. For 45 feet the track rests on a solid main shaft, 20 by 20 inches, which is rounded at four places where it revolves on heavy cross pieces gouged out to fit it and supported by piles. This main

shaft does not run in the middle of the track, but is nearer the inside rail; to be exact, the distance from its edge to the outer rail is 20-1/2 inches and from the other side to the inner rail 14-1/2 inches. When a car is run on the tipping section and the levers are released, it tips over toward the dump and the logs are thrown into the water. The track is prevented from going down too far by a piece of timber or "brow" projecting inwards from the piles. The track is operated by the levers, two short and one long, which are held down to the platform on the inner side of the track by short steel bars hinged across them and fastened with a pin which can readily be knocked out after the car has been run on, the brakemen hammer out the tail-hooks and release the track by knocking out the latch-pins. After all the logs are off, they force the track back into place by standing on the long lever and fasten it by putting in the pins. The engineer backs the two empties on to a switch and hauls on two more cars to be unloaded. It takes three men about 40 minutes to unload 16 cars averaging something over 5,000 feet apiece, or 85,000 altogether.

One of the quickest ways of getting the logs into the water is afforded by the use of an unloading machine. This consists of a small engine in a box-car, with a short derrick which comes out over the logs and from which hangs a short line with a hook on the end. After the brakeman has jabbed the hook into the near side of the log, the engineer winds in the line, causing the log to be rolled over and off the end of the bunk.

After the engine has unloaded one car, it moves itself along to the next, running on a parallel track behind the main one. It provides its own motive power by a gear attachment on the wheels. The most remarkable feature of this method of unloading is the speed, since it can roll off bunk-loads in rather fewer minutes than there are cars.

In the unloading of flat cars, there is not much variety. Owing to the fact that the loads can be prepared for unloading before the cars come to the dump, it is possible for the track to have much greater inclination than on rollways built for trucks. The load on a flat car kept in place by a few blocks substituted for the original stakes, whereas the load on a logging truck may roll off any minute after the blinds have been removed. The inclination on tracks where flats are used may be as high as 12 inches, the slope being secured either by placing a stringer under one rail or laying the ties on a slant. Before the cars are run on the slope, blocks are put beneath the logs and the stakes chopped off. If the logs do not roll off over the blocks, the latter are knocked out by means of long poles which the men shove through from behind. If they still remain on the car, jacks may be resorted to. Two men can unload 100,000 feet, distributed among 16 flat cars, in about 45 minutes. In some cases the unloading is done by the brakemen; in others by the "rafters" or by both together.

RAFTING

As a rule the logs are unloaded into the main pocket of the logger's boom, which, to describe it roughly, is a large space surrounded by logs chained end to end and held in place by piles driven every 70 feet or so. From the main part of the boom the logs are poled into a long pocket some thousand feet in length and about 75 feet wide, where they are made up into sections about 70 feet square and chained together to make up a long rectangular sea-raft. This is towed to the mill, usually by the mill company's own tug.

Such is the usual procedure. It is, of course, quite possible that the logs may be shipped direct to the mill-pond and unloaded there. Or they may be dumped into a river boom, in which case it is quite likely they are not put up in a sea-raft, but are made up into what is called a "round boom," consisting of logs surrounded by seven or eight boom-sticks in a circle. These are used when the l gs are merely to be floated down the river to the mill-pond and not towed anywhere. Or the logs may be dumped into some river down which they float until caught near the mouth in a large boom, generally owned by a charter company. From this they may be put into either a sea-raft or a round boom, according to destination.

After the logs have been unloaded into the boom, - which we will assume to be a harbor boom, - they are generally

"sorted," that is, the first quality and the merchantable logs are poled into one part of the boom, the second quality into another, and the cedar or perhaps spruce, into a third. Sometimes the sorting is omitted, and they are put up into sections directly from the main or "standing" boom. The actual rafting can be done only when the tide is favorable. After the rafters have hung out the boom-sticks, that is, strung them together along the sides of the pocket, they swing back the "gap" stick, which goes across the entrance. It might be explained that all connections between the boom-sticks are made by means of the "toggle and ring" which run through 4-inch holes in the ends of the boom-sticks. These boom-chains, some 6 feet long and an inch thick, have a large ring on one end, and on the other what is known as a "toggle," or a long flat piece of iron fastened by a link going through a hole in the middle of it. The toggle can easily be slipped end first through the hole, but after it has been set at right angles will not pull out.

After having removed the gap-stick, the rafters pole the logs into the pocket, picking out the ones that are to be rafted and taking them down to the farther end. After they have poled the logs to the end of the pocket, they make up a section by "stowing" the logs, that is, placing them together and parallel with the boom-sticks on the side so that they will be towed head on. The layer of logs which is put side by side is known as a "tier," and is generally composed of logs of about the same length. Since the sections are about

75 feet each way, there are usually two tiers to a section. Across the end of the second tier may be placed "cross logs" or "swifters," in order to make the stowing closer and to prevent the logs from having too much play. A boom-stick is then put across the end of the section and fastened with boom-chains to the sticks on the side. In this way the rafters make up section after section until they have either finished the whole raft, seldom more than 14 sections, or have been compelled to stop work by the turning of the tide. Under favorable conditions, two rafters can make up half a raft, some six sections, in a tide. Allowing from thirty to fifty thousand feet to a section this means that they can in one tide, handle between two and three hundred thousand feet.

Making up rafts in harbor booms, where the tide is not swift, is easier and requires fewer rafters than similar work on rivers where there is a rapid current. The pockets, which are headed down stream, are quite often made simply by one row of boom-sticks in the middle. The rafters are quite apt only to hang out boom-sticks for three or four sections. One man lets the logs through the sorting gap into the pocket, down which they are guided by a second rafter until they are "stowed" close together by two more. The object of so much care is to prevent the logs from getting side on, since in a strong current it is difficult to pole them straight again. Where there are no standing boom-sticks on the outside, the sections are often kept from swelling out by a "swifter" put

across the end of the first tier of each section. A swifter usually consists of a rope dogged into the boom-sticks by a couple of small dog shaped like Indian arrow heads. After the rafters have finished the section and put a boom-stick across, they can remove the swifter. When they have made up all the sections for which they have hung out boom-sticks, they let them float down along the main boom-sticks and dog them somewhere near the end of the pocket. In this way, they complete the raft, letting down two or three sections at a time since this is easier than poling the logs down the whole length of the raft. In harbor booms, where the logs can be handled more easily, the distance to be poled, makes little difference.

A sea-raft generally is composed of about a dozen sections, roughly from 64 to 75 feet square. The number of feet in a raft, which of course depends on the size of the logs and the number of sections varies from 250,000 to 800,000. Sometimes, as in the case of a raft that has to be towed under a bridge, the sections may have to be narrower than 64 feet. Steel swifters, or "cinch lines," are occasionally used instead of boom-sticks, which latter are put across only at every third or fourth section. This is, however, a rather insecure way of putting up a raft and may result in a loss of logs should the raft encounter a storm on the way to the mill.

As to the manner in which round booms are made up, there is little to be said. The rafter dogs the two end boom-sticks to both sides of the gap, the logs as close as possible, and then fastens the ends of the boom-sticks together. When he takes the boom down stream, he uses a manila snubbing rope of some 4 to 6 inches in diameter to snub it past sheer-booms and through bridges, or if necessary, to tie it up to the shore while the tide is coming in.

The number of rafters employed on a boom depends upon the number of logs to be rafted and the ease with which this can be done. On one river-boom receiving 150,000 feet a day, four rafters are employed. Rather less than this number are necessary on harbor booms where the same amount is being handled. The boom boss receives about $3.50 and the other rafters from $2.50 to $3.00 a day. When the boom is remote, they generally "bach," that is, do their own cooking. Although, on account of the tides, their work does not take many hours a day, it is hard while it lasts.

SCALING

The scaling of the log is usually done after the raft has been made up and is still in the boom, although it is occasionally done at the mill on the landing. Besides the mill-scale, most loggers scale their rafts for their own satisfaction to see how their estimate compares with that of the mill.

Scaling a log consists of calculating its volume in board feet of 1 by 12 by 12 inches. The factors to be considered are the length of the log and the diameter of the small end, since any wood outside of an imaginary cylinder of these dimensions is assumed to be of no value to the mill. The diameter and the length, however, give only the cubic contents, and to obtain the actual board feet something must be deducted to allow for the waste along the side, and for the saw-kerf. Calculations have been made as to just how much this would be for logs of different diameters, and log-charts or scales have been worked out, giving the number of board feet for all combinations, from a log 20 feet long and 14 inches in diameter upward. One of the formulas by which this is obtained is re-printed from the McTaggart Log Chart, by the kindness of Mr. Edward McTaggart, of Anacortes, one of the best known scalers in the State:

"Formula and Device - Multiply the diameter by itself once, then by nine (9) again, and again by the length of the log, which result shows the number of cubic inches contained

in the log; this divided by the number at the head of the column - (i.e., column of logs of different lengths, but with the same diameter) - shows the total feet in the log as expressed in the quotient.

"Example - The diameter of a log being 14 inches and the length 20 feet; applying the principles of the table, we have the following result: 14 x 14 = 196 by 9 = 1,764 by 20 = 35,280; divided by 213 taken from the head of the column, gives 165 as the total feet in the log."

Of course all that needs to be put on the chart is the diameter and length - one in columns running along the top, the other in rows crossing them - and the resulting number of feet at the intersection of the various diameters and lengths. In doing the actual scaling, whether on the landing or at the boom, the scaler is equipped with a scaling stick and a sheet of paper or notebook, in which to record the results. The scaling stick is made with an arm at the end for the purpose of getting the diameter, this part, as well as the handle, being marked in inches. On the sides of the stick, various lengths are printed, together with the corresponding board feet of the various combinations. The scaler finds the diameter of the small end, measures off the length of the log, and records the board feet in his notebook. Sometimes he is aided by a man who measures the lengths for him. Some scalers use sticks which are not marked to show the board feet. In

such cases, they mark a tally on their board at the intersection of the various diameters and lengths and afterwards look these up on their chart.

This description of scaling is so far somewhat misleading, since it gives the impression that scaling is a purely mechanical process which can be performed adequately by anyone who can read figures. Such as far from being the case. In reality it demands a great deal of judgment and experience. This holds good chiefly in regard to logs that are partially unsound, badly curved or injured by wind shakes. Any of these defects decreases the amount of lumber that can be taken out of a log. No scaler can tell the loss exactly, but a good one is supposed to approximate it. The amount to be deducted is particularly difficult to determine in the case of trees that are rotten inside. In the matter of shakes, the scaler also has to use some judgment. If they are close to the heart where the lumber is poor anyway, he does not deduct much. Nor does he take off much if they are well in from the bark, so that some lumber can be obtained outside of them, but if the shake is within 6 inches of the bark everything outside is usually discounted. A scaler has also to allow for any curve in the log. In general, scaling is so largely a matter of judgment that it is perfectly possible for two conscientious men to come out very differently on the scaling of the same raft.

The scaler has also to grade the raft, that is, to record the quality of all the logs. As a rule the first quality

logs and the merchantable ones are rafted together, while the seconds are put by themselves. He has also to record any sticks over 40 feet in length, since for these the logger is paid extra in proportion to their length, receiving 50 cents more a thousand for sticks between 40 and 50 feet, and $1 a thousand for every added 10 feet above 50. On the other hand, the scaler may have to throw out some logs altogether, as being too rotten to afford any lumber.

There is much variety in regard to where and by whom the logs are scaled. The railroad scale - taken on the landing - is generally known as the "road-scale;" the one taken in the water being called the "mill-scale." It is not uncommon for the mill and the logger to agree on some neutral scaler who visits the logger's boom and scales the raft there. Most of the mills give scale for logs of any diameter; those which are still using circular saws do not, as a rule, take any logs over 60 inches.

A number of different scales are used, the commonest being the Scribner. The men who scale for the logger may be paid by the thousand or by the day, the usual pay being between 3 and 4 cents a thousand. One well-known scaler at Seattle charges 5 cents a thousand for scaling rafts containing less than 300,000 feet and 3 cents a thousand for anything over that. Since an expert can look after more than a million feet between morning and evening, he may make over $25 in a day. A wellknown scaler is quite apt to be called on as referee, and has many

opportunities to earn more than his regular salary. It is a position of much responsibility and to say a man is a successful scaler implies not only that he is a man of judgment, but that he is one of absolute integrity.

The logger's responsibility ceases after the raft has been scaled and handed over to the tug. If the raft is broken up and some of the logs are lost, he can get his money if he can prove that it was well put up. Such, at least, was the decision rendered in a recent suit. As a rule, the towing does not cost the logger anything and his only remaining expense is in having his boom-sticks towed back. This costs from 25 cents to $1.25 apiece, according to the number of sticks and the length of the two, which is sometimes, although rarely, as much as 100 miles. Some loggers prefer to sell the boom-sticks with the raft and to make new ones for each succeeding raft. The towing back of the boom-sticks completes the cycle of the log's progress.

RIVER LOGGING

River logging in Washington may be divided into two classes; logging into navigable rivers, and logging into "driving" creeks which require damming. On the larger rivers, the logs may be made up into round booms, or rafts, close to where they are dumped in, or they may be allowed to float down stream to some charter boom where they will be boomed and rafted. On the smaller rivers or creeks the logger may either build dams

which enable him to get his logs down during the greater part of the year, or simply haul his logs into the bed to wait for the next freshet.

What river logging there is, is chiefly into the larger rivers. The bulk of Puget Sound logging is done on claims tributary to railroads. On the other hand, logging in the Southern part of the State, more particularly in the region around Gray's Harbor, is done chiefly on driving creeks.

Some idea has already been given of the first kind of river logging. The logs are either yarded directly into the river or hauled there in one way or another. They may be rafted at the logger's own boom or be left to float into a boom farther down. Booms owned by charter companies are situated near the mouths of many rivers. On small streams the booms may be built entirely across, but as this is not allowed on navigable streams, they are generally made in a pocket along one bank. All the logs that come down are caught by means of a device called a "sheer" or "rudder-boom," which is put in a little above the main boom. A "rudder-boom" consists of a long, narrow platform some 6 feet wide and rather longer than the breadth of the river. It is chained at one end to the bank, or to a heavy dolphin, and can be swung out at an angle across the greater part of the river by means of a number of rudders projecting along the side. The rudders are operated by a steel cable wound by a capstan at the end of the platform. These booms sheer off all the logs to one

side of the river just above the main boom, so that they cannot help going into it. When a boat wishes to pass, the boomman lets out the cable, thus allowing the rudders to lie flat along the boom, which swings back along the bank. When the boat has passed he "sets" the boom by winding in the cable until he has hauled the rudders to their original position.

After the logs have floated down into the charter boom, they are rafted out by the company's rafters. The exact manner in which this is done, depends on the construction of the boom; but as a rule they are taken out along the sides into round booms hung at the gaps. Sometimes these booms are allowed to float down to the mill, and sometimes they are taken to a rafting pocket near by where the logs can be put up into sea-rafts. Occasionally the logs are put up in sea-rafts right out of the boom. The charge for booming and rafting is usually about 60 cents a thousand.

The logger who takes out his logs along a small creek may do it either by simply hauling them in and waiting for a freshet, or by damming the creek and driving them through to tide-water. In the first case he is saved the expense of building dams, but, on the other hand, has to wait a long time before he can get his logs to market. He can not take advantage of any temporary rise, or fill short orders, and when he does put his timber down in the autumn, is apt to find the market well stocked. Another smaller disadvantage is that he can not safely cut long sticks since they are apt to create a jam which can not be broken

up, even by "splashing," i.e., letting water down from a dam. The proportion of river logging done in this way is extremely small.

In a rough way, the scheme of logging with dams is something as follows: The logger begins by building a dam at a suitable dam-site where the banks of the creek are high and near together, after which he proceeds to log into the river from both sides as far as the back-water reaches. As fast as the logs reach the creek they are poled down close to the dam, so as to be convenient for driving. The gate is opened when the dam is full and as many logs are let through as the head of water allows. The logger generally drives as often as he can, perhaps once a day, perhaps once a week. In summer he may not be able to drive at all. After he has logged off the timber along the sides to the limit of the back-water, he moves farther up and puts in a second dam. Sometimes as many as five dams may be built on the same creek, the distance between any two depending on the fall of the streams. Before driving to the lower dam the logger lets out most of the water, to avoid breaking it.

A troublesome feature of river-logging is the jams. The logger may break them by bucking up some of the logs, or by splashing, that is, opening the gates, and setting his rafters to work with peaveys and jacks while the current is turned on. If he does not succeed in "unloading" the logs in this

way, he may have to break the jam with powder or dynamite; more commonly, however, he moves in a yarding donkey which breaks it quickly and without the loss of timber, which ensues when powder is used.

When the logger is about to close down for the winter, he goes through the work known as "sacking" the rear, the rear being the name for the logs that catch or "hang" on bars along the banks. The sacking is done by a yarding donkey, which moves along the bank, hauling the stray logs into the current. As a rule, from 100 to 200 logs can be sent down at one drive. The number is limited only by the head of water, which on large dams may permit as many as 500 to go down at one time.

Occasionally time is saved by logging into an upper dam-pond, poling the logs opposite a landing by a railroadtrack, and then hauling them on cars to tide-water; thus saving the time and trouble of driving them through a lower dam. In this case the logger is put to the expense of making a railroad, but he can only handle long sticks with impunity, but can also fill short orders.

The expense of building dams may be avoided by loggers who have claims along creeks near tidewater. In such cases, tide-gates are put in through which the logs are let out at high tide and which held the water during the ebb. Sluices are also dug occasionally in swampy country with some success. The logs may be poled down the sluice sometimes for more than a mile and a half, to the main river. The dimensions of a sluice seen by

the writer are approximately as follows; depth 6 feet; width at bottom 4 feet, at top 8 feet. It was made at about the rate of one rod per man a day, the work being hastened by the use of powder. It is kept partly filled with water by means of small sluice gates, which can be pulled up to allow the turns to go through. The turns are made up of logs dogged together, sometimes aggregating 20,000 feet. They are poled down by two rafters for a distance of a mile and a half, in about an hour and a half. Such a sluice provides a cheap method of transportation, but the proper natural conditions for it seldom can be found.

The advantages or disadvantages of river logging as compared with logging to a railroad seem to be largely a matter of opinion. In place of the cost of shipping and rafting, there would be substituted about 60 cents a thousand for boomage, which includes rafting. On the other hand, river stumpage is rather higher than that on timber tributary to a railroad, sometimes running over $1.50. Then a certain proportion, say 5 per cent of the logs are lost. On some booms this loss is minimized by the presence of Indians living near the boom, who make a business of returning lost logs. A certain amount, about 1 per cent on 60 per cent of investment, must also be thrown out on account of the dry months when the logs can not be driven. Altogether in most river logging there is more risk than in logging to a railroad.

CAMP BUILDING

A typical logging camp consists of a group of rough wooden buildings, comprising a cook-house, one of two bunk-houses, a blacksmith shop, and usually a stable and a few "shacks." It is generally situated beside the railroad track, on level ground and as near water as possible. If not a railroad camp it may be near a river or the Sound, or close to some road, possibly a rough one that the logger has swamped out himself. The number of buildings and their general arrangement depends largely on the number of men employed and on the natural conditions. In describing the different buildings the writer has in mind those usually found in camps employing from 40 to 90 men.

As a rule the men sleep in the bunk-houses. These are from 40 to 70 feet long, 20 to 30 feet broad, and from 20 to 30 feet high. The sides are made of rough one-inch boards and the roof of cedar shakes. There are usually doors at both ends, although sometimes they are placed in the sides. Around the walls on the inside are ranged two tiers of bunks, made of boards, covered with hay, and separated by partitions. The bunk-house is usually heated by a large stove set in the middle with a pipe running up through the roof. Windows in the ends sometimes assisted by skylights, admit light to the room. Most bunk-houses are built to accommodate 30 men or more and some with three tiers of bunks are constructed to hold over 60. Bunk-houses holding between 20 and 30 men are most comfortable since

they are cleaned more easily and the men are not overcrowded. An important factor in the comfort of the men is the camp flunkey. His business is to sweep out the bunk-houses, keep fires up in cold weather, and do other small jobs around the camp.

The cook-houses vary as much in size as the bunk-houses. Often they are in the building used for the office. Usually they are long and narrow, and about the size of the bunk-houses, divided into two parts, the kitchen and the place where the men eat. There are two and sometimes three long tables with benches along the sides. In the kitchen are the ranges, sinks, tables, shelves, and so on. Adjoining the kitchen there is usually a small storehouse and sometimes a small covered place to keep meat. The cook-house is in charge of the cook, usually a white man, who is aided by one and sometimes two flunkeys who do the waiting at meals, and help in the kitchen work. At some camps women are employed as cooks and at a few there are Chinese.

The stable is about the same size as the other buildings, but usually somewhat broader. The inside varies from camp to camp, but a common arrangement is to place the stalls along one side, reserving the opposite space for harnesses, hay, grain, and so on. At all camps, even at those where no horses are used, there is a blacksmith shop, which usually consists of nothing more than three sides and a roof built over the bare ground. The repairing of blocks, hooks, and so on is usually enough to occupy the blacksmith's time.

Besides these buildings, there are usually a few "shacks" for the foreman and any of the crew who prefer not to sleep in the bunk-house. At some camps there are larger shacks put up by the married men for their families, or occupied by three or four congenial loggers. There is often an office, with a small store carrying a supply of lumbermen's clothes, tobacco, and so on, and at railroad camps there is an engine house, and possibly a repair shop. Some arrangement must be made to obtain water, such as a ram, steam pump, a pipe from a creek, or a well.

As all buildings are put up in much the same manner, a description of the building of a bunk-house will give a fair idea of the way in which the others are made.

The builders begin by clearing and grading. Then they sink rows of blocks, or short logs serving as posts, where the sides of the building are to be; if it is to be a large one they put a third row down the middle, placing the blocks about 12 feet apart. On top of the blocks they lay sills some 4 by 6 inches, and on the sills nail 2 by 4-inch joists about 2 feet apart for the flooring to be nailed on. Next are put in the upright corner boards, which are two 8-foot boards nailed together at right angles. From corner board to corner board are put 2 by 4 inch plates to which they nail the side boarding, afterward placing battens over the cracks. One-inch flooring, sometimes doubled, is generally used.

After this they lay 2 by 4 inch joists on top of the plates and running from side to side. These beams which keep the house from spreading, are placed about 6 feet apart in order to coincide with the ends of the bunks. On the rafters is nailed 4 by 1 inch sheeting, and on this the cedar shakes, some 40 inches long, are laid.

To avoid the expense of rebuilding at each camp many loggers have adopted portable houses. These consist of parts about 6 feet long, each comprising either one side, the floor, or the roof, so that four parts, when put together, make a section of the house 6 feet long open at both ends. The side sections are hinged to the flooring and bolted to a beam running along the side of the house. Oneffairly large portable cookhouse which accommodates about fifty men is eight sections in length by three in breadthş or about 40 by 18 feet. The total number of sections is 38, which at $4 a section, makes the house cost $152. Some of these portable houses are extremely comfortable, and being made of double one-inch boards are rather warmer than the ordinary ones; others are built so narrow and low as to furnish very cramped quarters for the men who have to live in them. Their chief recommendation is the ease with which they can be put up and taken down.

The cost of building camp is extremely variable, depending upon the camp-site, the facilities for taking in lumber, the number of buildings, and so on. A camp of ordinary size can be put up in a week by ten men. For labor at $2.50 a day,

allow $150; 40,000 feet of lumber at $8.50 a thousand would be about $350 more; which, with the cost of transportation and that of the smaller furnishings, doors, hinges, pipes, etc., to say nothing of the landing, would make a total of about $700. This exceedingly rough estimate applies only to large camps built for over 60 men. Small camps such as those which have the bunk-house and cook-house in the same building, and consist only of this and a stable, could be put up for a relatively insignificant sum.

It often happens that camps made by loggers owning locomotives are among the best built. Since the men can get to their work in time even when it is more than a mile away, the same camp may be used for two or three years. At one railroad camp seen by the writer, a noticeable improvement which served to make the houses much warmer, consisted of a board ceiling put in at a height of about ten feet.

Making the landing is generally counted as part of camp building. These are from 45 to 300 feet long and are usually made on the side of a small knoll. Sometimes they have very little slope, sometimes as much as 3 feet in 60. When they are made on a knoll, the work consists chiefly of grading, putting in the landing skids some 8 feet apart and notching them into the brow skid, which runs along the edge of the track. As a rule, the brow skid rests on cross pieces in order to bring it up to the proper height. A lead-log may be put in on the farther side of the track for loading purposes. When there is no knoll nearby, the logger may have to build up a landing, notching his

skids into stringers running parallel to the tracks, the stringers being raised, if necessary, on short bed-pieces. Such a landing is boarded over with puncheon. A large landing built in this manner may require 60 days' labor, not to mention the wear on the cable. The cost of timber need not be counted, for the bulk of it would have little or no market value, being either hemlock or of poor quality.

A unique landing is that made of three or four skids laid on the ground level with the track with others sloping sharply up to the brow skid, which is raised to the same height as that of the cars. This sort of landing requires no grading to speak of, and can be put in for less than fifty dollars. The cost of the larger ones may run up well over one hundred dollars.

SKID ROAD CONSTRUCTION

It is important to run skid-roads through the thickest stands of timber and, if practicable, to put them where the logs can be yarded down hill. Before laying out the road, the foreman usually "cruises" the country pretty thoroughly, after which he "blazes" the trees where it is to be swamped. Sometimes he merely indicates the general direction, leaving the blazing to be done by the "skidders," as the man is called who superintends the construction of the roads. The skidder has under him a gang of skid-road men who begin work by swamping. They are helped by a skid-road team of two or four horses, which "chunks" out the "right of way." Occasionally a small donkey-engine is used in place of a team. Stumps are blown out with powder.

After the road has been swamped, grade sticks or "hubs" are put in to mark the height to which it is to be graded. Sometimes it is to be filled up to the "hubs" and sometimes cut down to them. As a rule, it is better to cut than to fill, since the former method ensures a more solid foundation than the latter. Some skidders put in grade sticks by eye while others survey the road in a rough way. A simple method employed by some consists in sinking the skids and then grading to them, but this is impracticable in hilly country where much grading is necessary. After the grading the men buck up and bark skids, usually of hemlock, 11 to 12 feet long and from 10 to 18 inches in diameter.

These are laid in trenches about 9 feet apart when the road is on level ground. Dirt is tamped in underneath to raise them to the proper height, after which they are "saddled," that is, slightly gouged out in the middle in order to keep the "turns" in place.

On curves the skids are differently placed; instead of beingnat right angles to the road, they are put in at such an angle as to cause the turn to slide away from the tree or post on the inside of the curve and to accentuate this sliding the inner ends of the skids are raised. Some skidders instead of setting their skids at a slant, prefer to get all their slope from small "sheer" skids, which are laid sloping above and between the main skids. The chief advantage of using these small skids instead of sheering the big ones is that the skidder dan more easily change them to the angle which proves best adapted for the turns. Where the logs are to be hauled by a road-engine the skidder puts as few curves to the road as possible, since they make harder work for the engine, cause more wear on the cable, and necessitates the use of rollers. These are made of steel or of white metal. Their object is to prevent the cable from wearing against trees or posts. At the tops of ridges there may also be bottom rollers to sustain the downward pressure. This roller is usually set on a "fender" log alongside the road. At the foot of a hill a top roller may be necessary to keep the cable from springing up. A common form is a solid heavy roller about 10 inches in diameter by 1-1/2 feet in length,

with flanges at the ends to keep the line in place. This is set in solid bearings which are spiked or bolted to the flat surface of a tree or post on the inside of the curve. It can stand a heavy strain and is large enough not to wear the cable much.

Another form of roller is thinner and longer, and of something the shape of a rolling-pin. The bearings in which it turns are nothing more than long spikes with eyes in the end. These rollers are more easily put up than the others since they require little "surfacing" of the tree. On the other hand, although they do well enough on small curves, they can not stand the strain on sharp turns. There is also a third kind which is not much used and yet seems to possess manifest advantages over the other makes. It has small grooves running around it and instead of turning on axles, in bearings, it is hollow, and turns on a solid bar. This roller lessens the wear on the cable by presenting a concave instead of a flat surface, and also by preventing the line from playing up and down. It can be set up quickly and, what is more important, can take the place of top or bottom as well as side roller. All that is necessary is to set it at a slant; the grooves do the rest. On sharp grades these grooved rollers are especially convenient.

As a rule, however, the skidder avoids sharp grades since if they are near the landing the cable may have to be unhooked from the head log. If the turn has to be pulled up hill it may have to be smaller than would otherwise be necessary.

Whatever the grade, the skidder tries to have his skids near enough each other to make sure the log will rest on three at once. On sharp dips where the turn seems likely to "nose into" or "snub" the skids, he may put them near together and on very sharp inclines he may put in what are known as "fore and afts," or skids laid close together and parallel to the skid-road instead of across it. Ingenuity is often required to prevent the logs from coming down hill too fast and fouling the line. A common expedient is to put spikes into the top of the skids. Less often channels are made in the earth but in these dirt chutes the big logs are apt to bind, and the turns wear a bad hole at the bottom in a short time.

When the skidder has to run his roads through low and swampy ground he generally lays his skids on large logs, called "stringers," running parallel to the road. As a rule, the skids are squared and notched solidly into the stringers, although some skidders prefer to make small notches and to keep the skids from being jammed together by putting braces between them. These are, however, apt to be shaken out. When the road crosses a gully, the skidder usually has to crib up, that is, to build up stringers and cross-pieces one on top of the other until he reaches the proper level. The cribbing is kept from slipping by "saddle" notching slight grooves out on the bottoms of the logs to fit the tops of the logs below. If the gully is deep and not too broad, the skidder may decide to span it. The bridge shown in the photograph is a remarkable

example of this kind of building. It is made of five stringers between two and three feet in diameter, with fenders on the outside. It was built in three weeks by fourteen men working with a yarding-engine.

Skidding for horse hauling differs in several particulars from ordinary skidding. There must be no considerable upgrades to the landing. Puncheon, i.e., some kind of flooring, usually split cedar, is required during the rainy season, since without it the roads become so muddy as to be almost impassable, especially in clayey soil. In gravelly soil a new road can be used for some time without it. The usual way of laying puncheon is to place the pieces side by side between the skids. When the skids are on stringers, the planks may be held down by logs laid across the ends and pinned to the skids. Sometimes small branches or saplings are used instead of planks.

Another difference between ordinary roads and those built for horse-teams is that the latter can be made much more curved, since there are no rollers to be put in and no cable to be worn. Also, since there is less strain on them, the skids need not be sunk so deep in the ground. A piece of hardwood, dovetailed into the middle of the skid such as maple, not only makes them wear much longer, but by providing a smoother surface, lessens the friction. Hemlock is chiefly used for the skids. They are sometimes made of cedar, but this is rather poor material since it "brooms" up very quickly. Young fir wears rather better than cedar, but is seldom used when hemlock is to be had.

It is impossible to say definitely how much timber can be taken out over a skid-road before it wears out, because so much depends on the care taken of it. Unbarked turns wear a road more rapidly than barked ones. As a rule, skid-roads do not have to last for much over 6,000,000 feet,aand even that applies only to the stretch of main road close to the landing.

The cost of skid-roads is generally reckoned to be about $1 a skid, or something less than $600 a mile. This estimate is usually exceeded in rough country where there is much cutting or filling, or where the country is thickly wooded so that a great deal of powder has to be used on stumps. The use of puncheon is another expensive item since it takes a good man to split and put down from 50 to 75 feet a day. Cribbing may also more than double the cost of ordinary skid-road. For ordinary roads a common estimate for a day's work is four skids to a man, including everything, from swamping to saddling. This estimate may be true as regards level country, but in hilly parts of the State from two to three skids comprise a fair day's work. Skid-road men are, with the possible exception of flunkeys, the lowest paid in camp. Their wages seldom exceed $2.25 a day, and sometimes fall as low as $2. Green men are usually put on the skid-road, from which they graduate to more skilled and higher paid labor. The road gang generally numbers from 6 to 12 men.

The head skidder, on the other hand, is always well paid, his wages running from $2.75 to $3.25. A good skidder

is worth it, as a poorly built road is apt to give the logger much trouble. He not only needs a great deal of judgment, but must be able to handle men.

CHUTES

Chutes are long wooden troughs made of logs, and are put in where the country is so steep there is no other practicable way of getting out the timber. As a rule they terminate at a boom, but sometimes they are simply part of a skid-road.

The chute may be said to consist of three parts: the top, which is cross-skidded like a skid-road; the "slip" or chute proper, which is made of "fore and afts," and the "apron," or bottom part which runs out almost parallel to the water. The cross-skids at the top offer less friction than the fore and afts, and make it possible to start the logs easily.

In making a chute, some loggers work up from the apron, while others prefer to begin at the top. The apron generally extends somewhat over the water and is built almost parallel to the surface so as to prevent the logs from striking bottom. The logs or "stringers" on the bottom of the chute are bolted down to "bed pieces," which are merely heavy logs buried solidly in the earth. These bed pieces are set about ten feet apart under most of the chute, nearer together at the bottom where the most strain comes and farther apart for the upper stringers. The side stringers, which are practically fenders, are also bolted to the bed pieces and are firmly braced to prevent them from being spread apart.

In this way the chute is built up, the stringers being put in as soon as the necessary grading has been done

and the bed pieces laid. As a rule, it is best to cut rather than fill so as to insure a solid foundation. It is also important to make the chute slightly hollowed from the top to the bottom, instead of having it absolutely straight. A chute that is somewhat concave holds the logs in better than a straight one. The "dip" or "break" just above the apron should be gradual, otherwise the logs smash into the bottom stringers and wear them out quickly. To save these stringers, some loggers sink steel rails at the dip, but the chief objection to this is that after a while the rails are apt to splinter into the logs.

As a rule the turns are started down the chutes by being "snubbed" into them, either by a horse-team or by a donkey engine. At one chute they are rolled in off logging trucks and in order to give them a start, the logger has put in large iron rollers just above the cross-skids.

In general, it may be said that chutes are used only when there is no other convenient way of taking out the timber. They are hard on logs, especially cedar, which is apt to split when it strikes the water. It is impossible to give very definite figures as to the cost of construction. When there is little grading to be done, a chute may be put in for less than 75 cents a foot. Others may cost over $2 a foot. The estimate of a logger who had put in a great many is from $1.50 to $2. There is also the expense of keeping it in repair, as a chute is being constantly worn down. The wear can be lessened somewhat by putting in the stringers butt end up, but even then they seldom

last for over 10,000,000 feet. Some idea of the usefulness of chutes compared to other means of transportation may be gained from the fact that one company which had experimented with a long chute at one camp on being confronted with very similar conditions at another, decided to put in a switch-back. Nevertheless, for men who have but a few million feet on their claims, a chute may provide an extremely convenient way of getting their timber to the boom.

RAILROAD CONSTRUCTION

In regard to railroad construction done by logging companies, there is little to be said, since the track is put down in much the same way as on ordinary roads, except that it is seldom laid so carefully. For instance, when it is to be taken up again in a few weeks or months, it is seldom ballasted. The process of laying the rails might, however, be described briefly.

After the track layer has finished grading, he has the ties loaded on a push car which his men push out as far as the track goes and put down at the proper distance apart, usually about two feet. Then they run out a load of rails which they "strap" together, that is, join end to end by means of the ordinary "sticks" or "fish plates." They spike the rails to the ties, keeping them thenright distance apart by means of a "gauge." After this they "line" the track, that is, take out any slight curves, by prying it straight with crow-bars and

peaveys. They may "tamp" in some earth beneath the ties in order to make the track a little firmer, although this is thought unnecessary when the track is to be used for only a short time.

The weight of the rails runs from 25 to 50 pounds a yard. Some loggers use heaviest rails for branch roads, while others think it best to put them on the main road. They are mostly second hand, and when used much on curves become so crooked as to be troublesome to relay. They are usually laid with the concave side out, so that the locomotive can force them apart without fear of spreading them too much. The ties are sometimes hewed, sometimes merely split out of cedar. One company has them sawed out of its own timber at a cost of 9 cents apiece. The average price would, however, be about 18 cents apiece. As a rule, the grading and laying is done by the skid-road men, although at some camps it is done by contractors. The expense of putting in a road varies according to the cuts, fills and bridgework. For grading in fairly level ground, where the grades do not exceed 6 per cent a fair estimate is $24 a hundred feet, or a little over $1,200 a mile. For the actual laying, including strapping and lining, a rather conservative estimate is 100 feet a day per man.

BOOM CONSTRUCTION

Booms may, in a rough way, be classed as river-booms and those set on the coast or on ponds. A sea-boom consists of one large enclosure with rafting pockets leading out of it in

which the rafts can be put up. The arrangement of the pockets varies somewhat. Instead of one large "standing" boom, there may be two or three, each for a separate "brand" of logs. As a rule, there is one main boom into which the logs are unloaded. When it is not practicable to run the track directly over the boom, the logs are rolled down to the water on sloping skids called "shore-skids." These are set at a fairly steep incline, otherwise the logs - particularly those that are at all square-sided, are apt to be badly hammered as they roll down. It is also desirable to have the track curve out into the water so the logs will be shot off to both sides, instead of being piled up on top of one another in the middle, as happens when the track is concave.

The least expensive boom has its boom sticks held in place by chains running down to what are practically anchors. These are called "dead-men" and consist of two solid planks, some 15 feet long by 2 feet broad, buried in the beach at right angles to each other and held by a chain running through a hole in the middle, the other end of which is fastened to the boom-stick. A great objection to this form of boom is that it is more apt to be broken up by a storm than one made with piles and booms set in exposed places are stronger when made with "dolphins" instead of single piles. A "dolphin" is a cluster of piles driven close together and cinched with steel cable. The boom-sticks, which are usually some 14 inches in diameter at the smaller end, are apt to be rather heavier on these exposed booms.

A rough estimate of the cost of a sea or harbor-boom would be from $1,500 to $2,000 for one solidly made and large enough to receive 150,000 feet a day.

River booms are of two kinds: small ones put in by single loggers, and large ones usually controlled by boom companies. On small creeks the private booms may consist of nothing more than boom-sticks stretched from bank to bank, but as a rule, they have pockets running along the bank of the river. To prevent the logs from drifting back to the main boom with the tide, "cut offs" are sometimes put in. These are logs, somewhat longer than the width of the pocket, which are chained to one side. When the tide is running out they lie flat along the boom-sticks; when it comes in, they are swung over against the other side.

The larger booms are generally situated near a river-mouth and below a sheer boom. Sometimes a "trap boom" is also put in somewhere above the main boom to relieve the pressure on it. This consists of heavy dolphins with boom-sticks between them, arranged in the shape of an arrow-head or funnel pointing down stream. The gap at the end of the funnel is usually open, but when there are so many logs in the main boom that more might carry it away, the gap is closed.

It is important in the construction of these large booms to make them strong enough to withstand freshets. In fact, the manner in which they are made is largely determined by the strength of the freshets. If the boom is on a river which is never dangerously high it may be made in one long pocket with

double boom-sticks and dolphins of perhaps three or four piles apiece. The boom-sticks are kept in place by "cross-chains" running from one to the other and braced by "guy-chains" from the dolphins. In this manner the strain is more or less evenly distributed, among the dolphins. The logs are not allowed to fill the boom in one solid mass, but are separated by "tail booms," which are boom-sticks running across at intervals of one or two hundred feet. In rafting, boom-sticks are hung out for one man's logs at a gap on the side into which they are sorted, while the other logs go farther down the boom. The rafters then sort out another man's logs from those they have let go by, and so on until they have cleared out most of the brands. If there are but a few belonging to different loggers left over, they may raft them together out of the gap at the end of the boom.

This sort of boom would not be strong enough for some rivers. A much more secure kind is that which instead of having one long pocket, is made in two parts: the main boom, which stands all the pressure, and a lower part where the rafting is done, called the "race." The logs are kept in the main boom, except when they are being rafted. This is built at a slight angle across the river, gradually approaching the bank until, at the end where the race begins, it can be joined to it by a 60 foot boom-stick. This main boom consists of something more than boom-sticks held by piles. Inside the row of boom-sticks and running parallel to them is a row of large dolphins a few

hundred feet apart and made of as many as 50 piles a piece. The tops are sawed sloping so that logs will slide up on them and be less apt to carry them away. These dolphins break the force of the logs and keep the boom-sticks intact.

The "race" to which this main boom leads, and from which it is separated only by one boom-stick, is simply a long narrow pocket with raised "bridges" or planks two or three feet over the water, running across every few sections. When the logs are to be rafted, a rafter is stationed on each bridge to pick out one particular brand and sort it into a round boom hung out on the side. The great advantage of this scheme is that by means of these bridges, the company is enabled to raft out any number of different men's logs at the same time. The drift can be allowed to go through all at once, whereas in the other kind of boom the drift has to be carefully sorted out, usually at one particular gap near the upper end.

A slight variation from this 50-pile dolphin boom is made by driving a dozen or so piles in a circle with some little space between them, and then drawing the ends together and cinching them so that the clump presents the appearance of a cone. They are intended for use on streams where the current is not so strong as to require the larger dolphin. They are not so strong as the others, but are cheaper.

DAM CONSTRUCTION

Logging dams may be roughly classed as large and small, the former being cribbed up out of logs, the latter consisting of

little more than planking driven slanting into the bed of a creek and braced against a sill running from bank to bank. This style of dam is available only on very small creeks, and plays a comparatively unimportant part in the logging of then state.

The larger dams, sometimes 40 feet high and over a hundred feet wide at the top, are found mostly in the Southern part of the state. The first requisite for a dam is a good site. If it is the first one on a river, it is generally built within striking distance of tide water. If it is one of several it is made not far above where the dam below it backs up, so the logs can be driven through to the lower pond. If possible, it is made at a place where the river-banks are high and narrow.

After doing the necessary clearing and grading, the logger puts in his "sills," large logs going across stream, with the ends solidly buried in the banks. Then he cribs up on these, putting in alternately stringers and cross-pieces, notching the bottoms only, except for the top parts on both sides of the gate, where the logs are generally notched above and below for greater security. All of the cross pieces, i.e., those going across the stream, are notched solid except the outside ones, to be covered with planking. After the sills are laid and the first row of stringers is in place, the cross piece above the up-stream sill is placed in position. It is pushed out toward the ends of the stringers until it reaches the right position relative to the sill, since on the angle

between the tops of these two beams depends the slope of the face of the dam. This slope usually equals a rise of about 12 inches in every 16. A wooden bevel square is generally used to determine the position of this first cross-piece and the succeeding ones are laid in line with it and the sill.

Before the face of the dam is planked the cross-pieces are hewed to a face and the ends of the stringers "scalped" to make an even surface for the boards. Most builders also place hemlock poles across the ends of the stringers, alternate with the cross-pieces, to afford additional bearing for nailing and to stiffen the face of the dam.

The face of the dam below the sill consists of a double layer of 3-inch planking, driven into the mud in the bottom of the stream and nailed to the sill. This is called "tow-piling." It is driven by hand with an improvised pile driver made of a log with peg handles, which is confined in a wooden frame and raised and dropped by two or three men. The tow-piling is usually driven to hardpan, the length necessary being determined by sounding with an iron bar. The flooring above the bottom sill is simply nailed to the cross pieces and sleepers. Its thickness varies according to the size of the logs used in the cribbing, the volume of water, and so on, but in all cases it is greatest at the bottom. Near the top 2-inch plank may be deemed sufficiently strong.

Near the middle of the dam is the "sluice-way" in which the gate or gates are set, and the "apron," or long sloping platform running back from it. The apron is built of logs notched

into heavy sills and with fender logs on each side. Its object is partly to prevent the head of water from undermining the cribbing and partly to chute the logs well out into the stream.

There may be from one to four gates, according to the head of water. They run in grooves made in the heavy posts set on the sides of the sluice-way, which is heavily planked. The gate is made heaviest at the bottom, the planking there being in some cases 6 inches thick, and decreases to 2-inch planks at the top. For raising it, there are various devices. One consists of a lever and ratchet wheel, on which is wound a chain from the bottom of the gate. Another concists merely of a lever which catches on a notched plate bolted to the side of the gate. The objection to these and similar devices is not only that they take a great deal of time and labor, but also that they allow much of the water to run away before the gate is open.

A more serviceable device, by which this can be avoided, is known as a "false," or "trip" gate, which is simply another gate about two feet back of the main one, hinged to the bottom of the sluice-way and when the dam is closed usually lying flat upon it. When about to open the gate, the operator puts on the "splash-boards," that is, the two top planks of the real gate. This stops the water from overflowing into the gateway and gives the logger a chance to manipulate his trip-gate. By means of a rope on a windlass set on the bridge above the gateway, he raises his trip-gate to the perpendicular and then connects it by cables to the bottom of the main gate. He next

pulls up the splash boards and allows the water to fill the space between the two gates. When it presses with sufficient strength against the trip-gate, it forces it over backwards, flat on the sluice-way. In its fall it hauls up the real gate and allows the water to pour through. When the operator wishes to close the gate again, he disconnects the cables running to the trip-gate, at which the main gate goes down with a rush. If it does not strike bottom, the logger may have to hammer it down with a maul. This trip-gate arrangement works very successfully except when there is such a head of water that much of it leaks through between the planks of the main gate. This makes it difficult to raise the trip-gate.

For the purpose of driving, there is usually a sort of platform in front of the gate, running out to two upright posts set on the corners of the sluice-way. These posts constitute the small end of a funnel which is made by two boom-sticks fastened to the posts and running back to the sides of the pond.

The expense of putting in a dam depends so much upon the natural conditions and the size required that no very specific figures can be given. In building a dam about 30 feet high, 60 feet across the bottom and 110 feet at the top, ten men and an engine were employed 15 days to put in the cribbing and 12 more days to complete it; altogether a total of some 270 days' labor at about $2.50 a day. A very liberal estimate of $8.50 a thousand for the lumber would come to $200, making a

total of something less than $1,000. The cost of a larger dam might easily be double those figures, which are presented only to give a rough idea of the cost of dam construction. In many cases this would also be considerably increased by the cost of bringing the lumber up the river.

EXPENSES

In the matter of expenses, the writer can present only a general idea of the normal running expenditures in taking the log from the woods to the mill. The original expense of starting camp would depend so entirely on the outfit it does not seem worth while to discuss it. The figures set forth below, representing the running expenses of a large Puget Sound camp, are presented as being in a way typical of logging to railroads along the Sound, and with the intention of giving Eastern lumbermen a rough idea of expenses in that region. They are based on an actual pay-roll during the summer months of 1899 and were obtained from a gentleman who had recently resigned from a logging company.

Cost per thousand feet:

Labor getting logs to car	$2.35
Shipping to boom	1.30
Booming and rafting	.08
Scaling	.035
Returning boom-sticks	.07
Stumpage	.50
Mill discount	.11
Total	$4.44

Price of merchantable logs		$5.50
	1st quality	6.00 to $7.00
	2nd "	4.00

As 20 per cent of the Company's logs were second quality, the average price received was \$5.20; \$5.20, minus a cost of \$4.44, equals an apparent profit of 76 cents a thousand. From this deduct 25 cents for wear on outfit, which leaves a profit of 51 cents a thousand, or a daily profit of \$46, the average day's work being 90,000 feet.

It should be remembered that these figures represent the expenses of railroad logging only, and that in what is known as "bull-sapling," as distinguished from the old first growth; also that they do not in any way represent the expenses of logging in the southern part of the state. Something may be said about the logging in that region after the different items of the first account have been touched on briefly.

The cost of labor in taking the log to the car is, of course, derived from the average number of feet per man and the average camp wages. The former might be put between 1,000 and 1,500 feet, and the latter between \$2.30 and \$2.80. As to the other items, they have already been mentioned specifically with the exception of the last two. In regard to stumpage, speaking broadly one may say that it is 50 cents a thousand on claims tributary to a railroad and \$1.25 on claims tributary to the Sound. This statement does not take into account other considerations which would have some bearing on it, such as the quality of the timber, the chance of taking long sticks and the general accessibility, which would also have much to do with the

price of claims when bought outright. For a quarter-section claim, that is, 160 acres, yielding from 5,000,000 to 6,000,000 feet, a very fair price would be from $4,000 to $5,000.

The price of logs of different quality has already been mentioned, but it should be borne in mind that the figures represent only the prices which prevailed along the Sound during the summer of 1899. In regard to the cutting of second quality; there is great variation. Of course a man who is paying high stumpage is not so apt to take second quality as one who is paying low stumpage or has bought his timber outright. In the first case it is possible that the cost of logging the poor grades may be greater than the price they will bring. One instance of very thorough logging was on the slashings of a mill-company owning the timber and logging to its own mill. They were taking down to 6 inches, being of course, sure of their market.

It is often urged in defense of the "slaughter" of timber that the mills will not accept second quality. The fact remains, nevertheless, that loggers along the Sound who were taking everything, found little difficulty in disposing of second quality. Of course the market for it is rather variable, and there undoubtedly are times when it is more or less difficult to dispose of. The most deplorable result of leaving the top logs is that they are usually absolutely wasted by the burning of the slashings in summer.

To sum up: Some loggers can make more by taking second quality, and some by leaving it alone. In the second case, the net result to the community is a loss of so much capital; to the logger it means a larger profit, or possibly the difference between profit and loss. One can not expect a man to log at a loss for the benefit of posterity, or even to be satisfied with a profit of 50 cents a thousand, when by slaughtering timber he may make 75 cents a thousand. Deplorable as is the waste from an economic point of view, it seems likely to continue.

The figures which were presented at the first part of this section, have little application to the logging in the southern part of the State. The writer regrets that he is unable to furnish a similar list of expenses for the logging in that region. When the price of merchantable logs was $5.50 along the Sound it was $4 in Gray's Harbor. Since the logging is practically all along the rivers, the cost of shipping is eliminated, but stumpage is rather high, being sometimes, though seldom, over $1.50 a thousand.

A source of profit which is scarcely germane to logging and yet one which at some camps brings in considerable revenue, is the cook-house. Board ranges from $4.50 to $5.25 a week. The expense of feeding each man, including the cook's wages, is, along the Sound, seldom as much as 50 cents a day,

and often rather less, so that a profit of 25 cents per man a day is not at all unusual. At some camps there is also a small profit from the store, but this is usually insignificant and need not be considered.